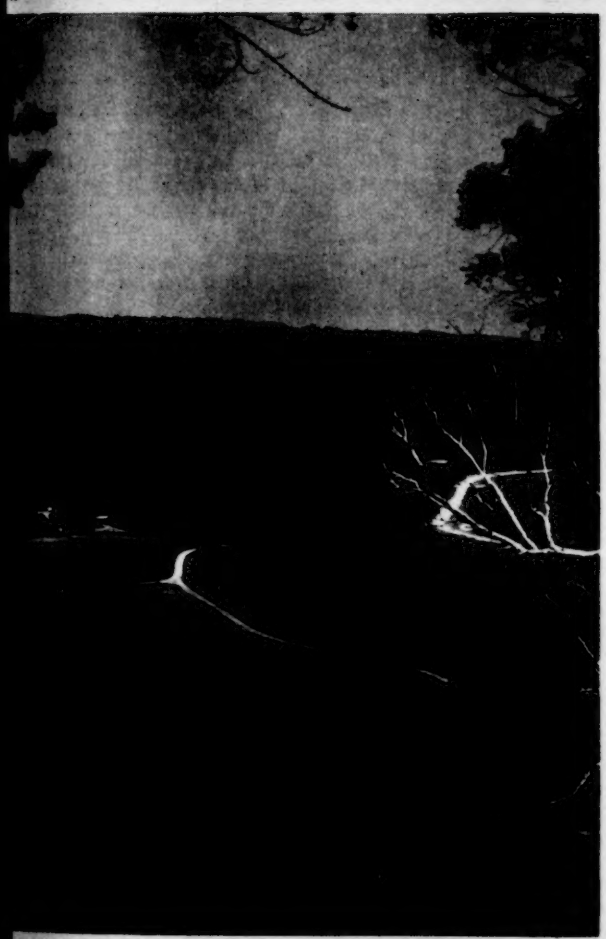

Volume 8, No. 3 **May, 1953**

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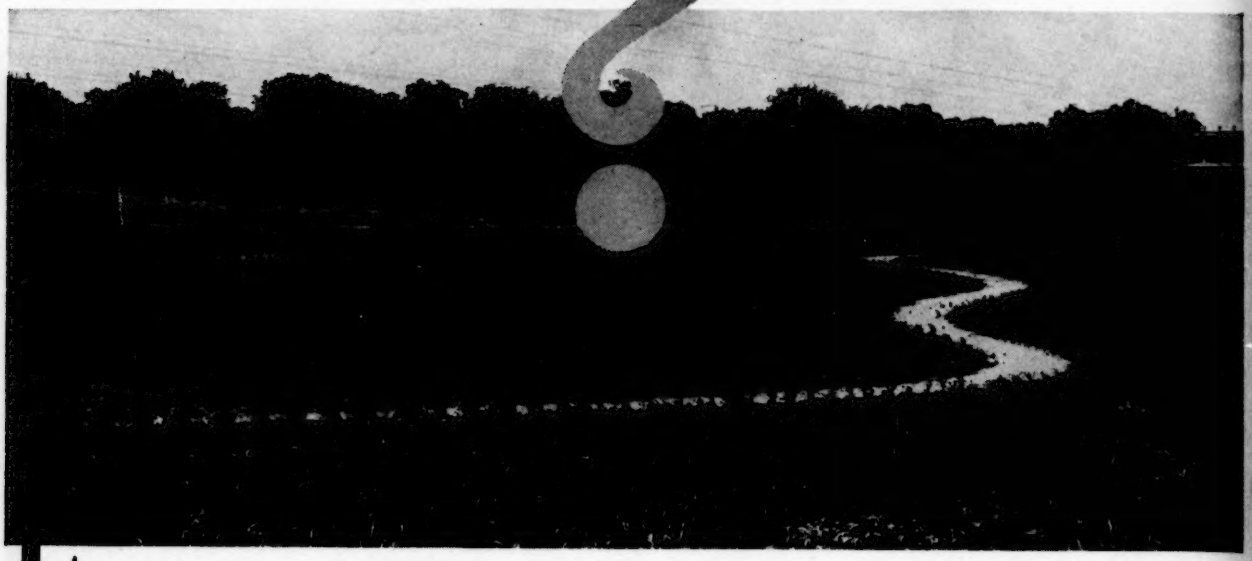
. . . R. W. Pearson and V. C. Jamison

Book Reviews: Economics of Agricultural Production and Resource Use, Principles of Farm Management, Land-Use Ordinances of Soil Conservation Districts, Food and Cover for Farm Wildlife and others

how do YOU figure the cost of a ribbon of silt



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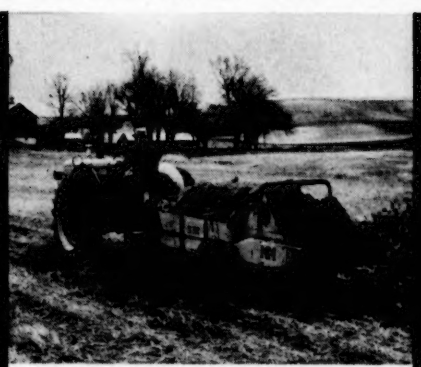

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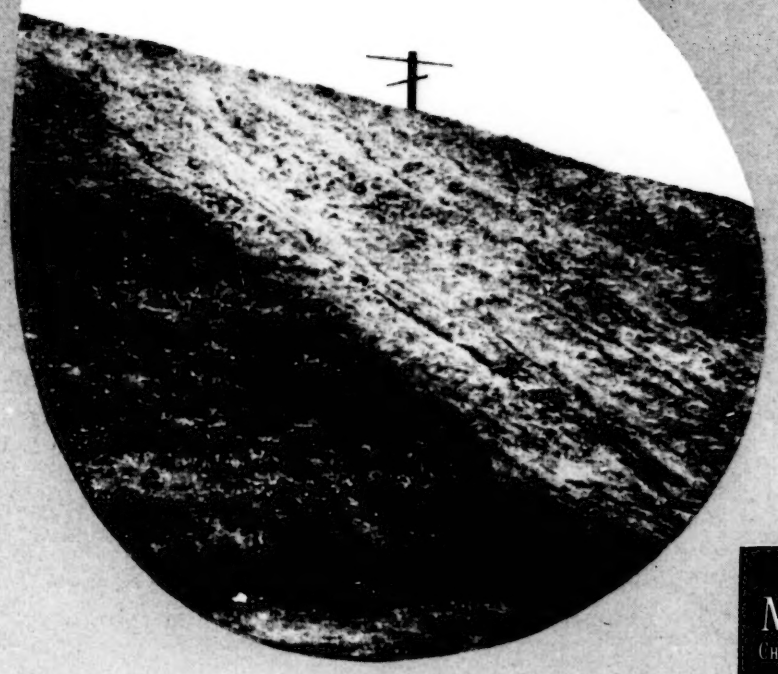

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Journal of SOIL AND WATER CONSERVATION

VOLUME 8
NUMBER 3

TO ADVANCE THE SCIENCE AND ART OF GOOD LAND USE

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The Cover

This beautiful valley can best be described by the words of Ralph Waldo Emerson: "He who knows what sweets and virtues are in the ground, the waters, the plants, the heavens, and how to come at these enchantments, is the rich and royal man."

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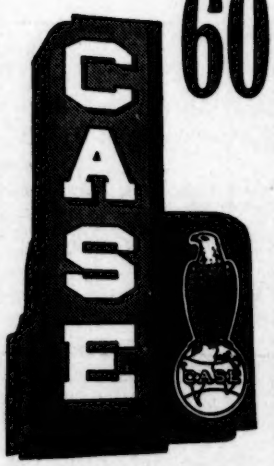

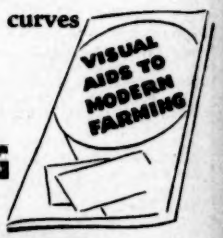

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Watershed Management in the Colorado Rockies

L. D. LOVE

The role of forests in watershed management has been known for a long time, but the advantages of a "managed" forest over a "virgin" forest have not been fully appreciated.

For example, studies in the Colorado Rockies strongly suggest that water yields can be increased by as much as 30 per cent when dense, virgin stands of lodgepole pine and Englemann spruce are thinned by the harvesting of the mature timber. However, this 30 per cent is the immediate response from the harvested portion and diminishes in time with regrowth of the stand. Under the desirable cutting practices, probably less than half of any unit would be harvested at one time and thus periodic harvesting and judicious thinning of young stands may produce a permanent increase of up to 15 per cent in water yield. In forests of this kind, erosion can be controlled through good cutting practices. There has been no indication that the cutting will cause an appreciable decline in water quality if appropriate methods of logging are used.

ON THE FRASER Experimental Forest in Colorado, watershed-management experiments have now been under way for about 15 years. This Forest, lying just west of the Continental Divide, is in the Colorado River drainage. It is located with a high-mountain zone (9,000 to 13,00 feet elevation) from which the abundant water is becoming increasingly important, not only within its own drainage but also through transmountain diversion to meet municipal and irrigation needs in the dry plains to the east. The annual water yield appearing as streamflow varies between 12 and 18 inches—nearly half of the annual precipitation. Dense forests of lodgepole pine (*Pinus contorta* var. *latifolia*), Engelmann spruce (*Picea engelmanni*), and alpine fir (*Albies lasiocarpa*) are characteristic of the Experimental Forest and the high-mountain zone within which it lies (Figure. 1). Virgin forest still predominates, but dense stands of second growth are common.

Watershed-Management Experiments

Most of the precipitation at these high elevations occurs as snow and the watershed-management experiments have dealt primarily with the effects of timber harvesting and thinning on the accumulation and melting of snow and the resultant effects on streamflow.

The usually gentle summer rains contribute little or nothing to streamflow. From each of the frequent snow storms during autumn, winter, and spring, the trees subtract a portion, holding it on their branches where it is exposed, in rounded stacks, to wind and sun (Figure 2). Much of this intercepted snow returns as vapor to the air. The snow on the ground becomes deeper and denser until the longer days and warmer weather of early spring begin to cause melting.

Watershed-management experiments at the Fraser Experimental Forest were first concerned with plots and more recently with complete, small watersheds. Initial plot studies dealt with the amount of rain and snowfall intercepted by tree crowns (2). Comparisons were made between a dense stand of young lodgepole pine, aspen (*Populus tremuloides*), and grassland. The variation in the amount of water reaching the soil under the three different cover types is summarized as follows:[1]

Source	*Lodgepole pine*	*Aspen*	*Grassland*
	Inches of water		
Winter snow storage	8.4	10.9	9.6
Spring precipitation	3.2	3.9	3.7
Summer prepicitation	4.0	4.4	5.2

The amounts of water reaching the soil from the three sources of precipitation between the lodgepole pine and both the aspen and the grassland, clearly show the effects of interception by tree crowns. One would expect more winter snow storage and spring precipitation to occur in the grassland than in the aspen, but in the grassland snow evaporation is increased due to a maximum exposure to sun and wind. This loss through evaporation is the main source of the difference between these two cover types.

Studies of snow evaporation over the whole winter and spring melting season showed that the greatest loss occurred after snowmelt began (9). These studies were conducted in an open park and included the period beginning with the first permanent snow in late fall and ending with the disappearance of the snow in the spring.

L. D. Love, charter member of SCSA, is a Forester in charge of watershed management research at the Rocky Mountain Forest and Range Experiment Station, maintained by the Forest Service, United States Department of Agriculture, in cooperation with Colorado A & M College, Fort Collins, Colorado.

[1] Results are expressed in inches of water. This is equivalent to acre-inches; thus, 12 inches on an acre equals one acre-foot of water.

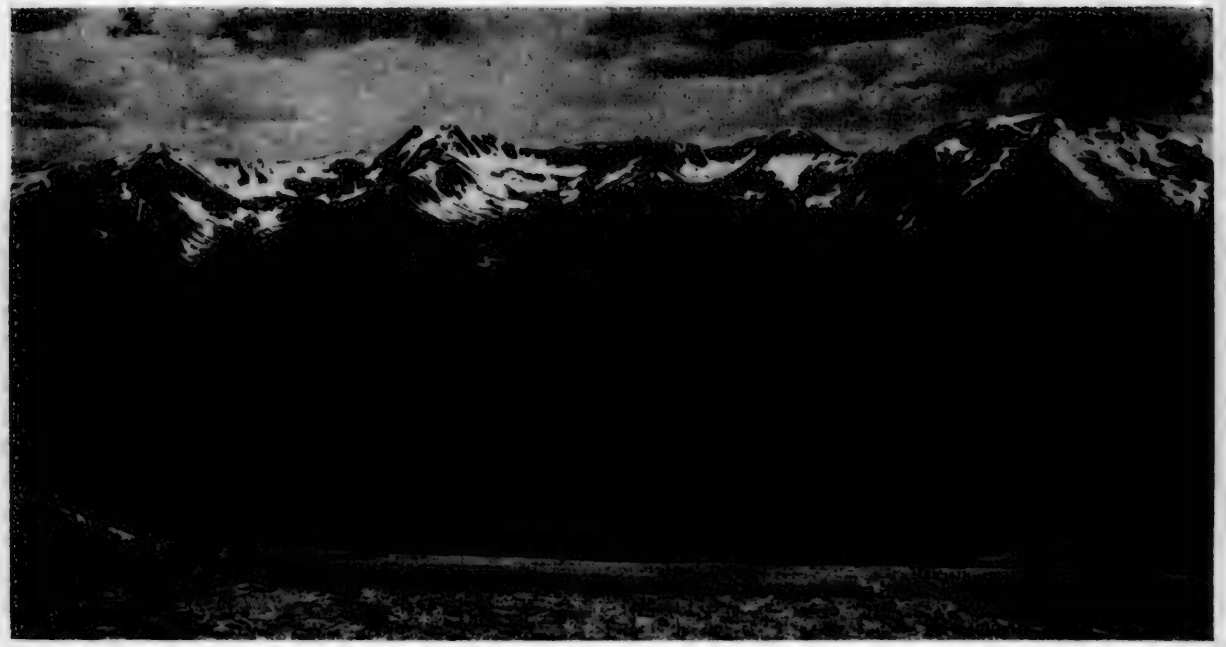


Figure 1.—Rough mountains are the water-yielding areas of the West. Annually, from 12 to 18 inches of water come from these high-elevation forests and alpine areas to supply water to the cities, industries, and farms below. (*Fraser Experimental Forest*)

A 4-year average gave the following results:

	Inches of Water
Winter evaporation	0.24
Spring evaporation	1.99
Total evaporation	2.23

Water losses from snow evaporation are less under a dense canopy of trees than from open parks and total 0.80 to 1.00 inch of water for the winter-spring season.

More detailed studies (9) were undertaken to assess the effect of timber harvesting on water available for streamflow. Twenty plots, scattered over a variety of slopes and exposures in a cover of mature lodgepole pine, were established to study the effects of different amounts of timber removal on water available for streamflow. Each of the plots was five acres in size, surrounded by a 3-acre isolation strip.

On the average, the plots had a timber volume of about 12,000 board feet per acre before cutting. All trees larger than 9.5 inches in diameter were cut on four plots; a 2,000-board-foot-per-acre reserve was left on four; 4,000 on another four; and 6,000 on another. Four plots remained uncut.

After the trees are removed in timber harvesting, more precipitation can reach the ground and, when allowances are made for losses due to interception, snow evaporation, and transpiration, more of the water from rain and snowfall is available for streamflow (Figure 3). The results of the study are summarized below:

Reserve stand	*Water avaliable for streamflow*	
Board feet per acre	*Inches of water*	*Per cent increase*
Uncut	10.34	None
6,000	11.38	10
4,000	12.32	19
2,000	12.44	20
0	13.52	31

Two methods of thinning a 35-year-old stand of dense lodgepole pine were employed to observe the effect on snow storage (3). On six ¾-acre plots, *single-tree thinning* left 485 of the better trees spaced 8.5 feet apart. On six other plots, *crop-tree thinning* consisted of cutting all trees in a 16-foot-diameter circle around each of 75 of the best developed trees. No thinning was done on six other plots. The water content of the stored snow was measured on all 18 plots. Below are summarized the results of the 3-year study:

	Snow storage	
Thinning method	*Inches of water*	*Per cent increase*
None	10.03	None
Crop-tree	11.72	16.8
Single-tree	12.34	23.0

Another study dealt with three different methods of harvesting mature spruce-fir timber. The study consisted of four 8-acre plots, three of which were treated differently, and the fourth left as an uncut control. *Alternate-strip clear-cutting* (Figure 4) removed 50 per cent of the volume by cutting all trees above 9.5 inches in diameter in alternate strips; *group-selection cutting* removed 50 per cent of the volume by cutting all trees above 9.5 inches in diameter in small circular clear-cut groups. In both these systems an additional ten per cent of the volume was removed from the remaining area by cutting overmature trees. *Single-tree selection* removed 60 per cent of the volume by cutting uniformly over the plot. No trees smaller than 9.5 inches in diameter were removed.

The effect of the three methods of timber harvesting on the water content of the snowpack on each of the plots as a whole, is reflected in the following 6-year averages:

	Snow storage	
Harvesting method	*Inches of water*	*Per cent increase*
None	12.4	0
Single-tree selection	15.3	23.4
Group-selection	15.3	23.4
Alternate-strip selection	14.9	20.1

The information obtained from the experimental plots is now being tested by a study of watersheds. The stream flow from a pair of adjacent watersheds was compared for a period of eight years; the watersheds

Figure 2.—Dense stands of timber intercept snow and limit the build-up of the winter snowpack on the ground. (*Fraser Experimental Forest*)

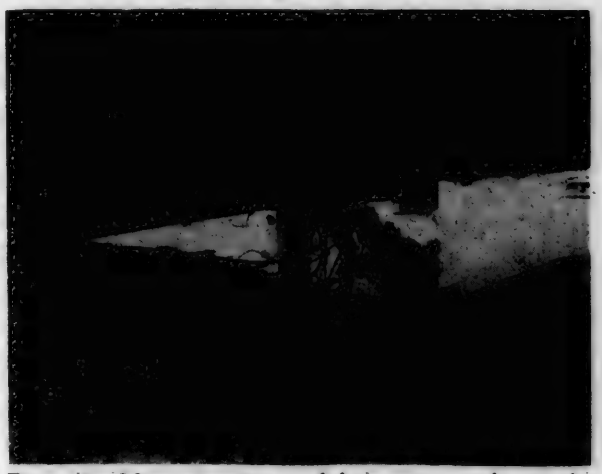


Figure 3.—More snow is stored between trees than under them. By taking advantage of this fact, thinning dense stands of young trees and harvesting mature trees opens the stand and allows more snow to reach the ground. (*Fraser Experimental Forest*)

were left in their natural, undisturbed condition. One of the pair—Fool Creek, having an area of 714 acres—is now being subjected to treatments associated with the utilization of the timber resource. The first treatment consists of the construction of some 13 miles of logging road necessary to the economic removal of the mature timber. This road network was completed in 1951 and its effect on streamflow and erosion is now being determined. The second and major treatment will consist of the removal of the six million board feet of saw-log size timber from the Fool Creek watershed. Half of this volume will be removed in one operation, probably in 1954, and the remainder removed at a later date when the effects of the first cutting have been fully determined (4).

The effects of, first, the road network, and, second, the removal of half of the large tmber, will be evaluated by continued careful comparisons between the flow of the two streams and by the measurement in a debris basin of the sediment brought down by Fool Creek. From the plot-study information, it is estimated that the annual yield of Fool Creek may be increased initially by the timber removal. The effect of the road network may or may not be appreciable. Both hypotheses need to be tested and will be.

It is also possible that the timing of the annual peak flow from melting snow may be somewhat altered. About 70 per cent of the annual flow of Fool Creek occurs during the period, April 1 to June 30, and the peak for the year comes in early June. Removal of timber from the watershed may accelerate the rate of snowmelt to some degree and may cause the peak to be

Figure 4.—Alternate-strip clear-cutting of timber increases snow storage and provides adequate protection to the soil. This is one system recommended for harvesting overmature timber from high-elevation forests. (*Fraser Experimental Forest*)

slightly higher and to occur somewhat earlier.

The study was specially designed to examine the effects of timber cutting on streamflow quantity and quality, but the timber resource cannot be overlooked when methods of watershed management are being explored. The forest remaining after partial harvesting will be studied to find out the damage by wind to the residual and less well-protected trees; the dispersal of seed from groups of standing trees into clear-cut areas; the effects of size of cleared area on the establishment of seedlings of each of the three species—lodgepole pine, Engelmann spruce, and alpine fir.

So far, the watershed-management experiments at the Fraser Experimental Forest show how it is possible to increase water available for streamflow by allowing more precipitation, particularly snow, to reach the ground through thinning and timber-harvesting methods. These methods open up the timber stand, thereby reducing the amount of interception of snow and rainfall by the tree crowns.

Results of the watershed experiments will not be known for several years to come. Yet it is possible to surmise what the results will be by drawing upon streamflow records of a stream draining a watershed where reduced interception has occurred during recent years in the timberlands.

To illustrate the extent to which reduced interception by trees influences streamflow, a study was made of the annual flows of White River in western Colorado. Streamflow has been measured at a gaging station near Meeker, Colorado, since 1934. The average annual flow from 1934 to 1952 was 427,620 acre-feet, or 10.52 inches of water over the watershed (1, 6, 7). The watershed area above the gaging station is 762 square miles.

Large areas of Engelmann spruce forest were infested and nearly all of the spruce trees killed by the spruce beetle (*Dendroctonus engelmanni*) between 1942 and 1945. Smaller areas were damaged during 1946 and 1947. Beetles kill the trees in one year, but it is not until the following year that the needles and small twigs of the spruce drop off and interception of snow and rain is reduced. On the White River watershed the trees on a 133-square-mile area were defoliated so that by the spring of 1947 decreased interception of snow and rain appeared to be reflected in increased stream flow.

To ascertain the effects of reduced interception by the dead trees on the annual streamflow of the White River, a comparison was made with the annual streamflow of Elk River, another stream in western Colorado, 60 airline miles to the northeast. The 206-square-mile watershed of Elk River has not suffered an infestation by the spruce beetle. Streamflow has been measured at a gaging station near Clark, Colorado, since 1937. The average annual flow from 1937 to 1952 is 240,840 acre-

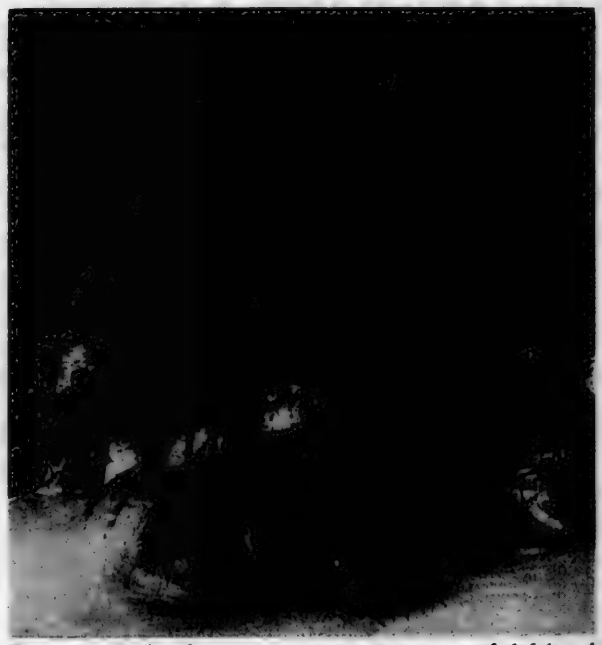


Figure 5.—Reduced snow interception in a grove of defoliated "beetle-killed" spruce. The level of snow is nearly the same under the dead trees as between them. Contrast with snow depression under adjacent live spruce (*right*). (*White River National Forest*)

feet, or 21.92 inches of water over the watershed (1, 6, 7).

Any variation from year to year in the streamflow of the Elk River can be attributed to the weather, mostly in the form of winter precipitation, and very likely any major change in the weather that would affect the Elk River watershed would also affect the White River watershed. Any such changes would be reflected in the annual streamflow of the two streams.

Annual streamflow is customarily summarized by water years; that is, from October 1 of one year to September 30 of the next. The 1947 water year includes the period from October 1, 1946, to September 30, 1947. Beginning with the water year 1947, a change occurred in the annual streamflow of White River as measured by the gaging station at Meeker, Colorado.

A summary of annual streamflow for Elk and White Rivers is found in table 1.

Table 1.—Comparison of the total annual streamflow of Elk and White Rivers for the period 1937-1952.

Before defoliation			After defoliation		
Water year	Streamflow		Water year	Streamflow	
	Elk	White		Elk	White
	Inches of water			Inches of water	
1937	23.79	8.11	1947	23.76	13.62
1938	26.21	12.19	1948	19.43	11.30
1939	18.48	9.16	1949	26.54	12.86
1940	18.39	8.86	1950	22.60	10.56
1941	17.82	11.06	1951	21.21	10.83
1942	20.38	11.72	1952	25.15	14.91
1943	21.09	9.28			
1944	19.79	9.79			
1945	26.34	11.34			
1946	19.69	8.94			
Means	21.20	10.05		23.11	12.35

Characteristics of White River means (inches of water):	*Before*	*After*
Difference due to weather and reduced interception	2.30	
Means adjusted for weather	10.29±.44	12.11±.57
Difference due to reduced interception	1.82±.72	
Error of the adjusted means for 95 per cent certainey	±1.00	±1.47
Error of difference due to reduced interception for 95 per cent certainty	±1.53	
Range of difference due to reduced interception for 95 per cent certainty	.29— 3.35	

Using the annual streamflow of Elk River as a net expression of variations in the weather, it is possible to adjust (by analysis of convariance) the annual streamflow of White River, before and after defoliation of the spruce, to similar changes in the weather with any remaining differences being the probable effects of reduced interception by the dead spruce.

After adjusting for weather variations, the difference between the annual stream flow of White River, before and after defoliation, would be 1.82 ± 1.53 inches, 95 per cent of the time.

The statistical analysis (5, 8) showed that in only three times out of 100 would the increased flow have been due to chance. We can, therefore, attribute it to the defoliation of the dead trees, which resulted in a reduction of the interception of snow and rainfall by the tree crowns (fig. 5).

Value of Watershed Management

Unused or unconsumed water on the watershed or in a natural stream has no value. The price of water to the consumer is determined by the cost of the dams, pipes, ditches, and pumps required to get it to him. Similarly, the value of timber on the stump is low—a few dollars per thousand board feet. Yet, we know that the use of these basic resources, and particularly water, results in vast benefits to society. Any increases in the usable supply of these resources are of very great value.

Data are available on one such case[2] and provide a concrete example of "cash" benefit inherent in watershed management. The City of Denver is being forced to go farther and farther afield to obtain new water supplies. Costs of extending, maintaining, and operating the new intake system have a unit annual cost of about $9 per acre-foot of water obtained and it is estimated by the municipal engineers that future planned extensions will have at least an equal unit cost. If water yield to the system now constructed could be increased, then future extension would be reduced and a monetary saving would result.

Our research indicates that water can be increased by 15 per cent on this municipal watershed which includes a portion of the Fraser Experimental Forest. The present annual yield with virgin forest cover is approximately one acre-foot per acre. Thus, the expense of developing this source of water supply amounts to $9 per acre per year. If the water yield is increased by 15 per cent, then the saving in the cost of tapping new watershed land will be 15 per cent of $9, or $1.35 per acre per year. This is a net value since the cost of managing the land to produce this increase in water yield is more than offset by the worth of the timber removed.

[2] Obtained through correspondence. No published records available.—Author.

Water is essential to life itself and to most of our activities as civilized people. Water for a city of one-half million people may cost the residents a mere $5 million a year. This is its market value which we can express in specific terms. Yet, the availability of the water means the difference between the existence of the city and its nonexistence — this is something beyond "dollar" values in a country with a rapidly expanding population.

In the western United States at least, water will probably fix the ultimate limit of population and standard of living. It is not too fanciful, then, to suggest that the value of increasing water yield from western watersheds is measured by the value of the increase in population and standard of living which a new water supply will allow. Watershed-management research, preparing as it does for the distant as well as the immediate future, can lay claim to a portion of the value inherent in a larger, happier population than could otherwise exist.

LITERATURE CITED

1. Colorado State Planning Commission, Water Conservation Board, State Engineer, Denver, Colorado. Data on stream gaging stations of Colorado. Appendix No. 2, Vol. 1. 1939.
2. E. G. Dunford and C. H. Neiderhof, *Influence of aspen, young lodgepole pine, and open grassland types upon factors affecting water yield*, Jour. Forestry 42 (9): 673-677. 1944.
3. B. C. Goodell, *Watershed-management aspects of thinned young lodgepole pine.* Jour. Forestry 50 (5): 374-378. 1952.
4. L. D. Love and E. G. Dunford, *The Fraser Experimental Forest—its work and aims.* Station Paper No. 8. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 1952
5. G. W. Snedecor. *Statistical Methods.* Fourht Edition, Iowa State College Press, Ames, Iowa. 1946.
6. Unpublished records. *Preliminary summary of the streamflow of Elk and White Rivers.* U. S. Department of Interior, Geological Survey, Denver, Colorado. 1951-1952.
7. Water supply papers. *Surface water supply of the United States:* Colorado River Basin. U. S. Department of Interior, Geological Survey, Washington, D. C. 1935-1950.
8. H. G. Wilm, *How long should experimental watersheds be calibrated?* Trans. Amer. Geophys. Union 30(2): 272-278. 1949.
9. H. G. Wilm and E. G. Dunford. *Effect of timber cutting on water available for stream flow from a lodgepole pine forest.* U. S. Dept. Agr. Tech. Bull. 968. 1948.

Soil Conservation In The Shan States

IRA K. LANDON

THE FEDERATED Shan States, one of the component parts of the Union of Burma, is taking its place in the world-wide conservation movement.

The Shan States occupy the east central part of Burma. This area is essentially a high plateau, varying from 2500 to 5000 feet above sea level. It includes a few comparatively narrow stream valleys and some rolling uplands, but is mostly rough, mountainous terrain. It is hardly self-sufficient in food production since it imports rice. The exports are potatoes, fruits, vegetables, minerals, teak and other forest products.

Interest was shown in soil conservation in the Shan States as far back as 1938 while still under the British regime. At that time some preliminary surveys of the extent of erosion were made and some Soil Conservation Demonstration Areas set up by the Forest Department. This work was interrupted by World War II and the Japanese occupation, but was resumed in 1946.

In 1949, the year after Burma was granted her independence, the Principal Forest Officer of the Shan States was sent to the United States to study the organization and the techniques of the Soil Conservation Service. Upon his return, a Five Year Plan of Soil Conservation was drawn up and adopted by the Shan State Government. Application was made to the Economic Cooperation Administration of the United States Government for assistance in carrying out this plan. A request was made for some soil testing kits, tree planters and fertilizers, and for the services of a Soil Conservationist to assist in organizing and launching the Soil Conservation Program in the Shan States.

The request was granted, and a Soil Conservationist was appointed in October 1951. The willing cooperation of the local technicians assigned to the project, and the active support of the administrative officials are proof of their sincere interest in soil conservation.

The original Soil Conservation Demonstration Areas had been located on lands that were so steep and so badly eroded that cultivation had been abandoned by the farmers of those communities. Operating on such lands where there was little soil left to conserve, they were more nearly demonstrations of soil reclamation rather than soil conservation.

In spite of the contour strip cropping, level terraces and rotations including green manures, the crop yields on these poor soils were low. Because of this the program was held in low esteem by the farmers and there

Ira K. Landon, a member of the SCSA, is Soil Conservation Program Advisor in the Shan States, Burma. He also served as State Coordinator, Soil Conservation Service in Kansas. From 1949-1950, Mr. Landon participated in an irrigation survey in Chile.

was little spread of the practice. As is frequently the case, the neighboring farmers felt that since the conservationists were "sitting on the cash box" they could do these things, but that it was not practical for the farmers to follow their example.

In order to remove the stigma of low yields and impracticality, some work was started with the farmers of one village on their own fields. In this cooperative effort the Soil Conservation Department is supplying only the technical "know how" and a little tractor work for the cosntruction of water disposal channels, the farmers agreeing to do their cultivation on the contour lines laid out for them. This work is only in the preliminary stages, but is being accepted by the farmers of this village for a fair trial. This type of work is to be expanded.

No data were available regarding soil and water losses under various conditions for lateritic soils under the rainfall of this region. One item for which assistance was specifically requested from E.C.A. was the establishment of a set of runoff plots to obtain some localized information, and also for demonstration purposes.

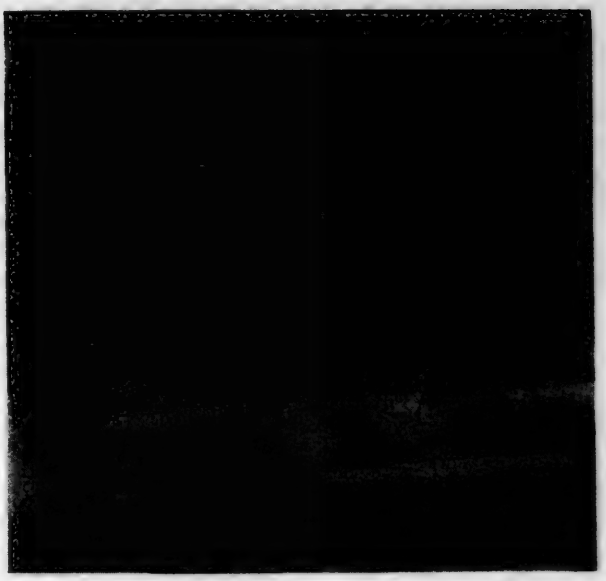
Soil and Water Conservation Runoff Plots Established

A set of nine 1/100 acre plots has been established on deep red lateritic soil with five per cent slope, which is typical of large areas of land used for the production of potatoes and upland rice. Concrete curbs and catchment tanks have been constructed. Cropping treatments will be started and soil and water runoff measurements will be made during the 1953 monsoon season.

The treatments of the various plots represent both the best available practices and those common in the community. Following the general scheme used on similar installations in the United States, one plot will be kept in grass. Four plots will be used for a rotation of green manure, potatoes, peanuts and upland rice with contour cultivation and good fertilization. Three plots will be in continuous potatoes, one in contour rows and two in hills, one of these being desurfaced.

The customary method of farming here is to plow the land, rake the loose soil into small piles about three feet apart, put the available crop residues and manure on these piles and burn them. For rice production the ashes are spread, but potatoes are planted in the ashes in the piles. In contrast, on the rotation plots and on the contour rowed plot of potatoes, the same amounts of residues and manure will be incorporated in the soil.

From these plots the differences in soil and water losses due to desurfacing, to rotation, to contour farming and to the conservation of organic matter can be measured. This set of plots is located on the outskirts of Taunggyi, the capital city, where groups of people



These soil and water conservation plots are in Taunggyi, S. S. S. Burma.

representing the entire Shan States gather frequently and can see the results.

Similar information is needed regarding the much steeper lands where "Taung-ya" or shifting forest cultivation is practiced. This is generally conceded to be a destructive practice but until more facts are known about it, and until the internal political and social conditions of the country are stabilized, little if anything can be done about controlling the practice by compulsion. A set of plots will be set up in the near future on a 25 per cent slope. The treatment on these plots will include forest cover, grazed grassland and cultivation.

All Land Belongs to the State

There is no private ownership of agricultural land in the Shan States, as it all belongs to the State. The land is operated by individual farmers as tenants, and herds of cattle graze where they will, which is usually close to the village site. Here the grass is grazed too close and too frequently. The result is that the more palatable grasses are suppressed and weeds and shrubs invade, reducing the forage production.

In addition to overgrazing the range land, it is the common practice to burn off all the old vegetation on cropland, pasture and forest each spring. This practice leaves the soil bare when the rains start, thus increasing the soil and water losses. The amount of this increase is not known.

For the purpose of demonstration, and also to get some factual data, two adjacent watersheds of approxi-

(*Continued on page* 144)

Nursery Tests the Best in Scientific Farming

HARRY R. SLAYBACK AND WALLACE A. MITCHELTREE

Complete soil management can be obtained by matching the crop to the soil, soil and water conservation measures, liming, fertilization, cover crops and rotations. The theme of the following article is that these facts are no longer in the realm of theory but necessary practical needs to secure maximum crop yields. It is interesting to note that the actual application of these methods finds the technician and the farmer doing more and more field planning and experimentation.

SUPPOSE YOU BOUGHT a 100-acre farm and decided to raise nursery stock. Suppose that in spite of all your efforts in the way of resting land, using cover crops, and planting hedgerow barriers you found 20 years later that it took six years to raise nursery stock previously requiring only five. That, in addition, the topsoil was being moved into hedgerows by the wind. That rainwater was washing tons of good topsoil into low-lying areas. That this topsoil had to be hauled back to fill the gullies every spring. That a $5,000 loss a year was being brought about by the soil washing away from plant roots on the ends of the rows. And that the purchase of an additional 200-acre farm only added to these problems and that some of this land had to be retired in a very short time because it was too wet.

The above brief description was the condition in which the late Roland deWilde, Sr. and his son Klaas of Perkins-deWilde Nurseries in Shiloh, New Jersey found themselves in 1942. In desperation, after seeing some soil stabilization demonstration work that had been established on nearby farms, they appealed to the South Jersey Soil Conservation District for assistance.

The overall plant-growing operations at the Perkins-deWilde Nurseries were complex and intensive. Grafts and cuttings, mostly of ornamental evergreens, were started in nursery hothouses. After they had started to grow they were placed for one year in cold frames or partial shade where heat and water could be carefully regulated. The plants were then ready to be transferred to the field. After three years these plants were lifted, graded and replanted in prepared fields on approximately 3-foot centers. The 3-foot-square spacing allows check-row cultivation. When the plants were about six years old they were lifted and balled for shipment. The area they occupied was planted to soybeans or cowpeas. This crop was turned under and planted to rye for winter cover. This procedure was followed from year to year as long as it was necessary to bring back the fertility of the soil.

Harry R. Slayback is Extension Soil Conservationist, and Wallace A. Mitcheltree is Associate Extension Specialist in Soils, New Jersey Agricultural Extension Service, Rutgers University, New Brunswick, N. J.

The addition of summer and winter cover crops to the soil was carried out for two or three years. In spite of this effort, plus fertilization, subsoiling, filling gullies and building soil dams the soil was washing from the fields much faster than it could be replaced. Evidently the traffic during digging, transplanting and cultivating up and down the slopes aggravated the soil-erosion problem. In addition, the nursery-cropped soil was open to winter elements and high-intensity rainstorms of summer. Balling and shipment of large amounts of soil with each plant added to the problem.

A close inspection by a technician revealed that although the nursery was following a fair rotation it would have to be improved. Due to the intensity of the operation and traffic in the way of transplanting, trimming, spraying, cultivating, and balling, the physical properties of the soils were being rapidly impaired. The elements were carrying off the most productive topsoil by the ton. An overall complete soil and moisture

—Photo by S.C.S.

Figure 1. One of the many erosion problems of Perkins-deWilde Nurseries in 1942. Note exposed plant roots.

—Photo by S.C.S.

Figure 2. *Left*. Spreading yew on contour. Beautiful uniform stock can now be grown in five years that formerly required six. *Right*. An ample supply of moisture was found near the surface in these contour planted Azaleas in dry summer of 1947.

conservation layout was needed. Mechanical barriers were necessary to prevent an erosion potential from developing on all nursery-cropped acreage. In addition, soil loss and poor drainage made it necessary to match the crop to the various soil conditions found on the nursery.

As soils weather down from their parent material they acquire certain characteristics related to the nature of their parent material, the climate, and the natural vegetation. This particular area of New Jersey receives about 45 inches of rain annually, which amounts to over 6,000 tons of water an acre a year. As water leaches down through the soil it carries with it from the surface many fine particles that are deposited in the subsoil. Consequently, a light topsoil and a fairly heavy subsoil have been developed. The soil has a fine crumb structure that is well stabilized by natural organic matter. But little or no organic matter is present in the subsoil to stabilize the soil aggregates. An overabundance of colloidal silica in the subsoil has a temporary cementing action when the soil becomes dry, causing the substratum to become very hard and virtually impervious to both roots and water. Long periods of wet weather are required to bring this subsoil back to a friable condition.

The natural topsoil on this profile, like all topsoil, is capable of withstanding freezing and thawing and impact of raindrops and still allow infiltration to take place. The subsoil, under normal moisture conditions, is well designed to allow rapid percolation. Once the topsoil is removed, however, the subsoil, because of its very weakly stabilized aggregates and its tendency to become hard upon drying, becomes one of the poorest infiltration materials that one can imagine. Even the best soil management will not repair this injury in any reasonable length of time. Consequently stabilization measures such as terraces must be relied upon to prevent runoff and further erosion.

Rainfall records of the area show that the critical period of erosion hazard is during the summer and early fall, with a peak during July. Proceeding on the theory that "any treatment or practice that brings about a reduction in runoff may be followed shortly by a relative increase in the extent of plant growth," the technicians knew they couldn't go wrong by first suggesting diversion terraces to take water from a point of harm to a point of control and to supplement all this with contour planting and cultivating of all nursery stock.

Solution of the Perkins-deWilde Nurseries soil problem provided an education in soil-conservation planning. No previous large-scale soil conservation program in nurseries was available for guidance. Problems of soil, drainage, construction, field arrangement and cultivation were solved by consultation in the field. Merger of the practical experience of the deWilde's and technical skills of the soils technicians resulted in 800 acres of the most outstanding example of nursery soil stabilization in this country.

In 1942-43 sheet erosion was rampant on all nursery acreage. Rill erosion was a common sight on about 60 per cent of the acreage, and severe gullies, one to three feet in depth, were present on about 20 per cent of the 300 acres. The question was—where to begin?

Approximately ten acres of severely eroded nursery acreage was set aside for the trial. This land had a slope of three to four per cent. Two 500-foot diversion terraces were constructed in the summer of 1942 on the critical part of this slope. These terraces were limed, fertilized and seeded to clover, alfalfa, and timothy. The

resultant protection from water wash was so outstanding that it was believed safe to plant on the terrace contour adjacent to the diversion terraces in 1943. Early in the spring of 1944 it was observed that sheet and rill erosion was present between the contour rows. This called for intensive study. The soil was found to be Aura[1] rather than Sassafras, and Aura soil appears as cappings in many parts of Cumberland County, where the nursery is located. Previous experience with this soil on intensively cultivated vegetable farms had indicated that the most rigid rules must be adhered to in constructing terraces and contour layouts. Otherwise, the areas must be seeded down to sod for varying periods.

The problem in southern New Jersey soils under such intensively cultivated crops as tomatoes, peas, beans, spinach, potatoes, fruit and nursery stock is one of promoting crop rotation or land resting. Farmers in this area have very little use for hay since they have no stock to feed. But they will be forced to use these tools to stay in business. At present the program of soil and moisture conservation depends entirely on stabilization and fertilization.

The deWilde soil erosion problems were very similar to those of many farms in southern New Jersey. The solution to these problems, however, was a horse of a different color. Ninety-five per cent of the established stabilization measures were arrived at in the field by using such tools as the soil auger, level, tape, lath, hammer, pencil, notebook, two-bottomed plows and tractors. Success with the first 10-acre field on a highly eroded area of problem soil aided greatly in planning the layout of the balance of the nursery.

[1]Deep phase Aura. The parent material of the Bridgeton Formation consists of bedded coarse sand and gravel overlain by silt. Silty layer may be from a few inches to over 20 inches in depth. The substratum except for ordinary dry weather hardening has some firmness with spotty looser beds.

The following rotation is now used on all nursery-cropped acreage. If the nursery crop is removed in May or June, soybeans are planted, followed by either rye, barley, or wheat with timothy. Clover seed is then sown in the early spring when the soil is wet. The grain crop is clipped. The timothy and clover is cut twice a year and the residue is left on the ground to be incorporated in the soil.

The change over from block layout of nursery stock to contour planting was complicated and expensive. New equipment had to be bought and other equipment altered. Experiments were carried out to find how sharp a curve could be handled efficiently. A new inventory system had to be figured out. Planting and spraying crews had to be closely supervised. Terraces and waterways had to be staked out in their entirety so that plans could be made two, three, and four years ahead for removing nursery stock to facilitate construction. Some terraces exceeded the safety limit of 1800 linear feet but operated efficiently at lengths of 2100 and 2300 linear feet under careful layout and construction. Waterways proved to be the most difficult item to establish. One waterway is ¾ of a mile long, the upper end being 15 feet wide and the outlet end 50 feet. Stone and corrugated pipe culverts were constructed wherever roads crossed the channels of terraces or grassed waterways. These culverts were inexpensive and were found essential to save wear and tear on equipment.

All diversion terraces are now maintained in a clover, alfalfa, timothy sod that must be mowed twice a year. About ten per cent of the nursery area is required for waterways and terraces. This is not entirely lost to cultivation because the hay collected is fed to horses and used for mulch. No effort is made to grow nursery stock on any of the terraces. A fine catch of grass and legumes is effected by liming and fertilizing.

—Photo by S.C.S.

Figure 3. Outlet end of ¾ mile 50 foot wide grassed waterway. Land in foreground was too wet for saleable crops in 1943.

The nursery today utilizes virtually all the water that falls on the soil. Only during long hard rains does any water leave by way of the terraces and waterways. Retaining the moisture has produced important effects that are readily noticeable to nursery personnel. There is no loss of soil from erosion. The soil is continually being improved by fertilization, cover crops and a better rotation. The roots of the plants that have been grown on the contour are larger and better developed than the ones that used to be produced before soil and moisture practices were started. And saleable plants can be grown in five years now rather than the six formerly required.

A number of other benefits have resulted as a direct result of the combination of good soil management practices. These benefits far overshadow any difficulties that have been encountered in adopting a good soil management program. As proof of this the deWildes have acquired four more farms totaling about 500 additional acres. As soon as the farms were obtained they were laid out for stabilization.

In July, 1952 the New Jersey Chapter of the Soil Conservation Society of America toured the Perkins-deWilde Nurseries and saw one of the best soil stabilization and one of the prettiest landscaping jobs in this country. Klaas deWilde is extremely proud of what they have accomplished and expresses himself in the terms of a laborer who worked for them: "She ain't pretty for nice but she's hell-damn for strong!" The technicians involved on this project now firmly believe that if a "landscaping" job of this type can be done for the nurserymen it can be done for any farmer in New Jersey.

—*Photo by S.C.S.*

Figure 4. A turn-row eliminates running over rows already cultivated when reversing direction. Tractors cultivate long rows on right and left of marker. Horse drawn cultivator works on short rows.

Four-H Soil and Water Conservation Project in Tenth Year

G. L. NOBLE

THE YEAR 1953 marks the tenth anniversary of the National 4-H Soil and Water Conservation Awards Program.

According to United States Department of Agriculture figures, more than 1,300,000 4-H Club members have received training in soil and water conservation since the inception of the program in 1944. Forty-six states have accepted the program for 1953.

The program, which is arranged and announced by the National Committee on Boys and Girls Club Work, is conducted under the direction of the Cooperative Extension Service.

The purpose of the program is to help 4-H Club boys and girls achieve the following objectives:

1. *To know the social and economic value of soil in their lives and to the nation.*
2. *To learn through 4-H Club work how to successfully conserve soil and water.*
3. *To cooperate in the farm family program of soil and water conservation for present and future production.*
4. *To prevent soil wastage and deterioration on the farms and in the communities.*
5. *To work together on a program important to the community, state, and national welfare.*

Some idea of how well the members taking active part in the project carried out the above objectives may be gained from the records of the eight national winners in the 1952 program, which are contained in this article. Each of these top ranking winners received a $300 college scholarship from The Firestone Tire & Rubber

G. L. Noble has long been associated with the Four-H Club movement. He is director of the National Committe on Boys and Girls Club Work, Inc. with headquarters in Chicago, Illinois.

Figure 1. Winners in the National 4-H Soil and Water Conservation program for 1952. Each winner received a $300 scholarship from the donor of awards, The Firestone Tire and Rubber Company, Akron, Ohio.

Company, donor of awards in this program since its beginning. They also received, together with eight other sectional winners, all-expense trips to the 1952 National 4-H Club Congress in Chicago. Additional awards in the program are a $25 Defense Bond to the state winner in the junior division, and in the Demonstration phase the state-winning individual and the two members of the state-winning team each receives a fountain pen and pencil set.

Regional Winners Achieve Outstanding Results

Brief outlines of the eight national winners' records in the 4-H Soil and Water Conservation program follow.

Eddie M. Folds, 18, of Granite Hill, Ga., started his soil conservation program by rebuilding a worn-out 400-acre farm with the aid of his parents, county agent and soil conservation technician. The program included test plots of lespedeza and crimson clover. First big strike from his soil-building work came in his fourth 4-H year when he was named district and state winner in his grazing project, and received a $200 cash award for building check dams and terraces. During last summer's drought he had a month's kudzu grazing to carry over his 17 head of livestock.

Jack L. Robinson, 18, of Middletown, Ind., and his father have completely covered their 100-acre farm with soil and water conservation practices, which have more than doubled crop and grass yields. This, in turn, has made it possible to raise and fatten about 300 hogs a year from the 35 acres of corn sown. The grass lands also support a herd of 32 registered Hereford cattle.

Ronald Elkins, 16, of Farmington, New Mexico, tackled the job of restoring 15 acres of abandoned land his parents had bought with 143 acres lying between two rivers. The tracts had grown up with cottonwoods and willows and had become waterlogged with seepage. Using a bulldozer, carry-all and leveler, Ronald, with the help of his father and a brother, cleared and drained the land, making their own concrete tile. When the job was done, soil tests were made and grass slowly established on the entire acreage, which now provides grazing for a flock of 35 Hampshire sheep and a number of cattle.

Milton W. Dufel, 19, of Fonda, N. Y., took his first step in applying soil conservation practices on his father's 224-acre farm when he laid 2,000 feet of drain tile and cut some open ditches with his own equipment. It made possible working wet spots. Milton then plowed up a permanent pasture which had been grazed for 30 years without improvement, and planted a cover crop of rye, preliminary to fertilizing and reseeding. In 1951 the father-son team was named champion at the county crop show for its year-around program of liming, fertilizing, drainage and crop rotation. In 1951 a farm pond was built and stocked with fish. A shrub border on the windward side of the farm was planted, and more than 1,600 trees have been set out in a 4-year program of reforestation.

The first step made by *James W. Harris*, 19, of Greenville, N. C., in his 4-H soil conservation project was to seed 10 acres of his family's 100-acre farm to permanent pasture in 1949 to support their 16 cattle. To prevent overgrazing, 21 more acres were seeded, this time with ladino clover and fescue grass. A 3-year crop rotation was laid out, and a program for raising hogs adopted which depends upon the use of new fields each year for farrowing and grazing, to prevent disease. Eight acres of weedland were cleared to provide new land for the tobacco crop. Since the fields are subject to drying out, an irrigation system which draws water from a canal running through the farm, was set up at a cost of $2,500.

Year by year starting in 1946 *Bruce J. Gillin*, 18, of Porter, Okla., and his father labored to restore a 200-acre upland prairie farm they bought eight years ago. They built terraces, limed and leveled pasture and crop land, mowed weeds and applied fertilizer. Several ponds were dug, and dams sodded. Gullies were filled. In 1950, remaining idle land was converted into a refuge for wild life. Oats and vetches have been grown to catch

fertility and save washing in winter. This year their corn showed the value of rotation. It had followed clover and stayed green longer, the ears were larger and the yield above average for the region.

Paul M. Saunders, 19, Arrington, Va., has worked with his father helping revamp the family's 563-acre farm to make every part contribute its maximum income. As the pair gained experience and vision of their job, they set a goal to have orchards, timber land and pastures on hills and cropping land on the bottoms, which skirt a river. Improvements which have come from the plan are a herd of registered Angus cattle on good pastures where mediocre cattle and pastures had existed; corn yields of 115 bushels per acre compared to 50; poultry and garden products in abundance; the planting of some select ornamentals in a nursery for landscaping, the purchase of three tractors and net profits of $7,000. These changes were achieved by the usual soil-saving practices of adapting fence lines to contour stripping, closing gullies, building check dams, removing forest areas from grazing and liming the land, fertilizing and re-seeding lands suited to grazing with legumes and grasses.

Jack Clouse, 21, of Taylor, Wis., and his father have radically changed the face of the hilly, gullied 200-acre farm the father bought in 1946. With the aid of the county agent and district soil conservationist, the pair has conducted a program of improvement which called for changing fields to better conform to the nature of the land, filling gullies, building terraces, applying lime and fertilizers and plowing deep and thoroughly. Along with the land rehabilitation, returns from the improved crops have been put into improvements. Jack says soil conservation is his best 4-H project, and it has kept him enrolled until the age limit in 4-H Club work.

That the program is proving its worth in helping to stop erosion of valuable top soil is reflected in the fact that 4-H Soil and Water Conservation projects have recently been started in a number of states. In Arizona, a "pilot" club with limited membership has been organized in Maricopa County to test methods of teaching the principles of irrigation and the relationships between soil and water and plant growths. Set up as a 3-year project, the first two years will deal with the basic principles of soil and water management, while the third year will emphasize the application of these principles by club members on their parents' farms.

States Conduct Conservation Demonstration Contests

A State 4-H contest in soil and water conservation demonstrations was used in North Carolina for the first time two years ago by Extension conservationists, who

Figure 2. A group of 4-H members examining a field which had been tilled to keep the stubble on the surface.

prepared five demonstration outlines and distributed to all 4-H Club agents and soil conservationist personnel, along with a copy of the Local Leader's Manual on 4-H Soil and Water Conservation provided through the courtesy of The Firestone Tire & Rubber Company. Very good demonstrations were developed.

Also in 1951, two soil and water conservation contests, one for a team of two boys or girls and one for individual, were held in West Virginia. The winning individual demonstration was on erosion illustrated by flats of soil with different types of cover. The winning demonstration team put on an excellent runoff demonstration consisting of five flats of soil with different types of cover. In both demonstrations, after the flats had been "rained on," the runoff water together with soil washed from the flats were collected in glass jars. A summary was made showing how water had been absorbed and how much was lost. This was also done for the soil washed out of the flats.

4-H Conservation projects were first included in the Michigan club program in 1934. From that time new projects have been added until the 4-H Conservation program in the Wolverine State is one of the largest in the country.

The Nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased; and not impaired in value.

—Theodore Roosevelt

It Pays to Invest Money in Soil Conservation and Related Farm Improvements

R. J. BECKER AND E. L. SAUER

In an effort to answer the important question, Does it pay to invest money in soil conservation and related improvements?, the authors have analyzed the records collected on 48 farms in Madison and St. Clair counties in Illinois for the ten-year period 1939 to 1948. The records were ranked on the basis of conservation expenditures per acre from lowest to highest.

CONSERVATION EXPENDITURES included costs of fertilizers, agricultural limestone, phosphate, potash, grass and legume seedings, grass waterways, tiling, ditching, terracing and other erosion control and water conservation structures and practices.

Farm improvements related to conservation included buildings, equipment, fencing, machinery and livestock to implement the conservation program and economically utilize forages produced as a result of the conservation plan.

From the array of 48 farms, two groups of ten farms were chosen; those farms with the highest and those with the lowest conservation expenditures. Comparisons were made between data on average inventory values, physical inventories, expenditures, land use, crop yields, livestock returns, net returns, per acre, and rates of return earned on investment for the high and the low-conservation farms.

In almost every individual measure, the farms with the higher conservation expenditures per acre ranked higher. Crop yields per acre were higher. Meat production per acre was higher. Milk production per acre and per cow was higher. As a result of these higher physical returns, both the net income per acre and rate earned on investment were higher.

The conclusions indicated are the same as those from many other similar studies: *conservation farming pays and it pays to invest money and time in soil conservation and related improvements.*

A more detailed presentation of the data summarized in the preceding statements follows with tables and charts that illuminate the conclusions.

Farming area studied. Madison and St. Clair counties are in southwestern Illinois, an area where wheat, dairy, and poultry are relatively important in the total farm income. These counties are in the heart of the St. Louis milkshed, and dairying is a major enterprise on many farms. The topography of these counties varies from the level Mississippi bottomlands in the west, with steep bluffs bordering the river valley, to rolling and level land stretching eastward from the bluffs. The bluffs are an area of highly productive deep loess soils. Much of the level land has little or no surface drainage and a slowly permeable subsoil. The farms in the two groups were paired, so that each group has an equal number of farms from the bottomland, bluffs, and flat to rolling upland.

Cash expenditures on high and low-conservation farms. The total cash expendituers per farm for soil conservation and related improvements are shown in Table 1. The ten high-conservation farms spent more for all items of conservation and related improvements. The ten-year expenditures by these farms for fertilizers, water disposal, legumes and grass seeds were almost three times as great as the expenditures by the ten low-conservation farms for these items, the total expendi-

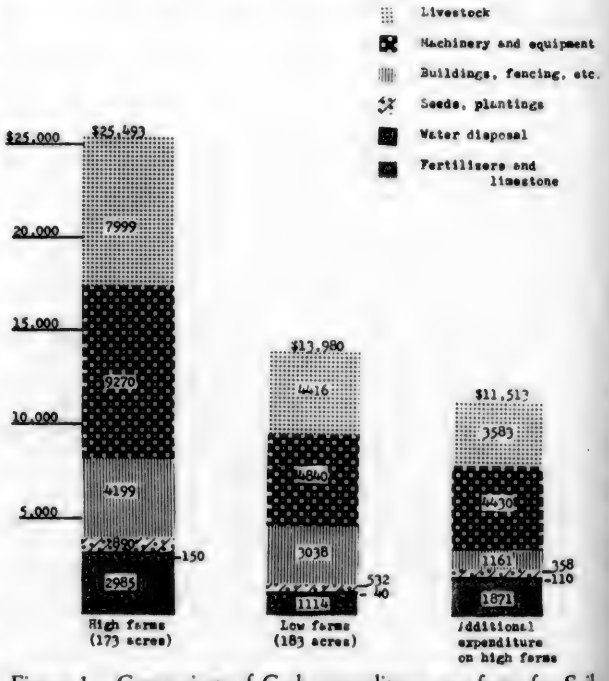


Figure 1.—Comparison of Cash expenditures per farm for Soil Conservation and related Improvements, 10 high and 10 low farms, 10 year total, 1939-1948.

R. J. Becker is Assistant in Agricultural Economics, University of Illinois College of Agriculture, and E. L. Sauer is Research Supervisor, Soil Conservation Service, U. S. Department of Agriculture. Both men are members of the SCSA.

Table 1. Total cash expenditures per farm for conservation and related improvements by 5-year periods, 1939-48, Madison and St. Clair Countis, Illinois.

Items	10 high farms		10 low farms	
	5 years 1939–43	5 years 1944–48	5 years 1939–43	5 years 1944–48
Acres per farm	161	184	189	177
1. Fertilizers				
Limestone	$ 293	$ 530	$ 78	$ 398
Rock phosphate	191	519	23	180
Super phosphate	56	170	31	70
Potash	---	139	31	---
Mixed fertilizer	207	880	42	292
Total	$ 747	$ 2,238	$ 174	$ 292
2. Water disposal				
Tile	$ 1	$ 4	$ 2	$ 2
Ditching	---	8	1	---
Terraces	10	1	---	5
Waterways	3	5	---	---
Other	16	64	2	26
Erosion control structures	29	9	---	2
Total	$ 59	$ 91	$ 5	$ 35
3. Seeds and plantings				
Alfalfa	$ 112	$ 198	$ 47	$ 99
Clover	94	222	64	203
Timothy and brome	16	22	3	9
Other and mixed	74	142	37	63
Trees	1	9	1	6
Total	$ 297	$ 593	$ 152	$ 380
4. Buildings, equipment, etc.				
Water supply	$ 34	$ 89	$ 20	$ 39
Roadways	14	87	24	31
Buildings	1,613	2,036	969	1,578
Fencing	144	182	141	236
Total	$1,805	$ 2,394	$1,154	$1,884
5. Machinery				
Tractor	$ 551	$ 994	$ 193	$ 858
Truck	122	704	20	556
Auto	206	1,195	606	177
Hay machinery	238	1,103	105	337
Other	1,220	2,937	912	1,076
Total	$2,337	$ 6,933	$1,836	$3,004
6. Livestock				
Dairy cattle	$ 451	$ 529	$ 574	$ 881
Beef cattle	315	70	711	826
Feeder cattle	1,952	2,740	658	306
Sheep	---	---	3	80
Hogs	840	1,102	169	208
Total	$3,558	$ 4,441	$2,115	$2,301
Total, items 1, 2, and 3	$1,103	$ 2,922	$ 331	$1,355
Total, items 4, 5, and 6	7,700	13,768	5,105	7,189
Total, all items	$8,803	$16,690	$5,436	$8,544

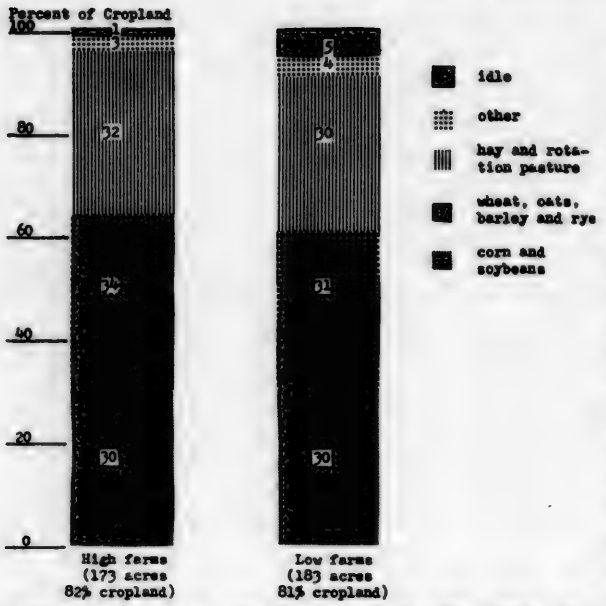


Figure 2.—Percent of crop land in various uses, farms high and low in conservation expenditures, 10 year average, 1939-48.

tures per farm being $4,025 and $1,686 respectively, or $2.33 and $0.92 per acre per year (Figure 1) The ten-year expenditure for buildings, livestock, and machinery was twice as great for the ten high farms as for the ten low farms, the total expenditure figures being $25,493 and $13,980 respectively, or $14.73 and $7.64 per acre per year.

The ten low-conservation farms increased inputs for water control, limestone and mixed fertilizers in the last two years, 1947-1948, over the first two years, 1939-1940, proportionately more than did the ten high-conservation farms (Table 2). Even with this greater increase, the expenditures by the ten low farms were less than those of the ten high farms. The result of this difference is higher yields and higher net profits for the ten high-conservation farms, as shown by later tables.

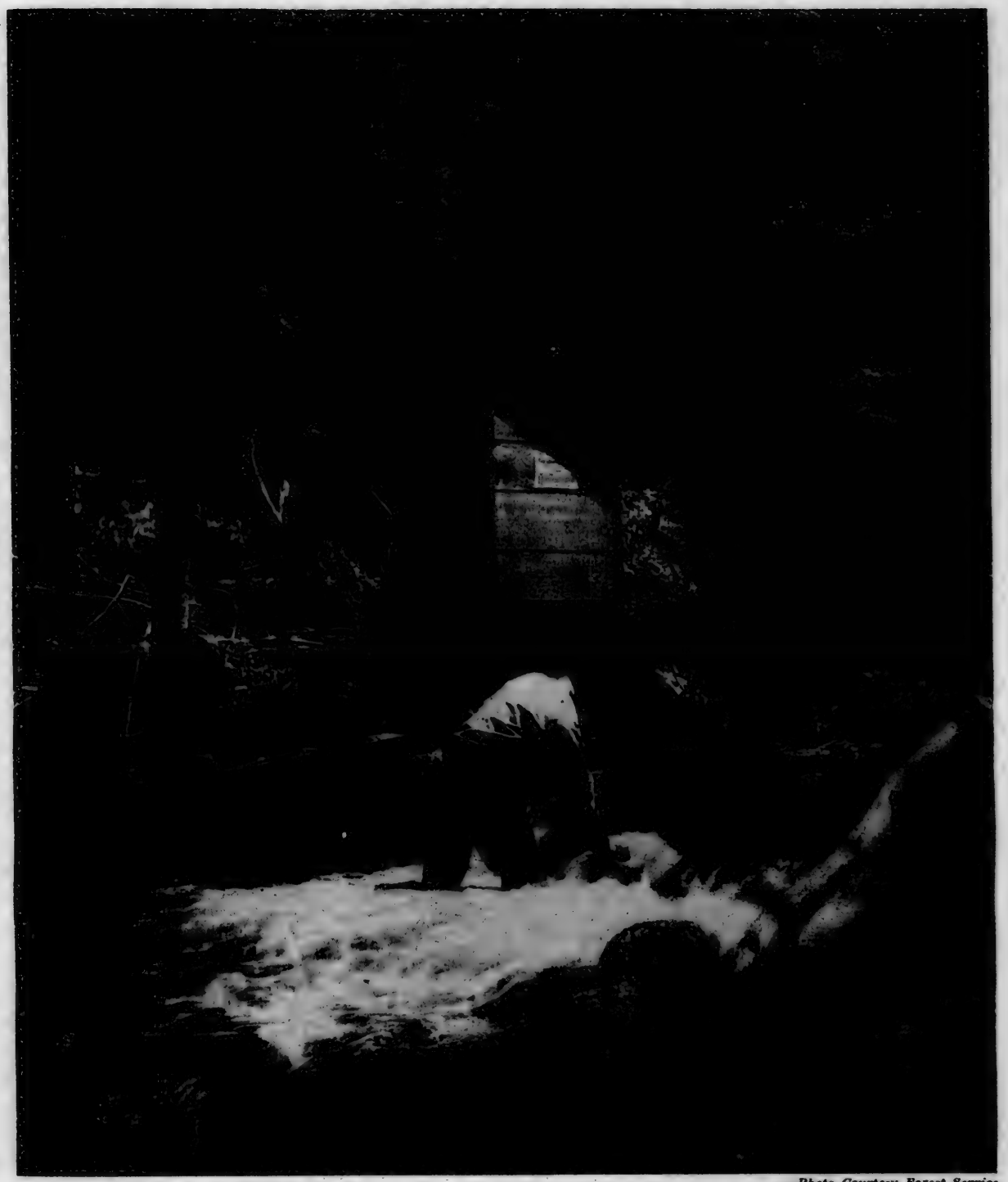
Land Use. The ten high farms had an average of 24 per cent of their tilled land in legumes (alfalfa and sweet clover) and a total of 32 per cent in hay and rotation pasture for the ten-year period compared with 20 per cent and 30 per cent respectively, for the low farms (Figure 2). The high farms had an average of eight per cent of their tillable land in non-legumes (hay and pasture) for the ten year period, compared with 10 per cent for the low farms. Only one per cent of the tillable land was idle on the high-conservation farms compared with five per cent idle for the low-conservation farms for the ten year period.

The ten high-conservation expenditures farms had slightly more tillable land in the small grains, oats, rye, wheat, and barley. Higher percentages of these crops would mean more soil fertility depletion for the farms, however, the inputs of fertilizer, phosphates, potash, and limestone plus the feeding of more livestock and return of more manure to the land were sufficient to replace the fertility loss and produce higher yields per acre.

Yields. The average yields per acre for the ten-year period show that the ten high-conservation farms had consistently higher production than the ten low-conservation farms (Table 3). The average yields of the different crops were calculated for the beginning and ending two-year periods for the two groups. These yield figures followed the pattern of all farms in the two counties and show lower per acre yields for both groups in the latter two-year period due to the unfavorable weather in 1947-48 compared to 1939-40. They show also that the yields for the low-conservation farms fell more than those on the high-conservation farms. The greater decreases for the low farms may indicate a decline in productivity of the soils of these farms. For example, corn yields per acre declined from an average of 55 to an average of 50 for the ten high-conservation farms, and from an average per acre yield of 51 to 44 for the ten low-conservation farms. The high farms showed no

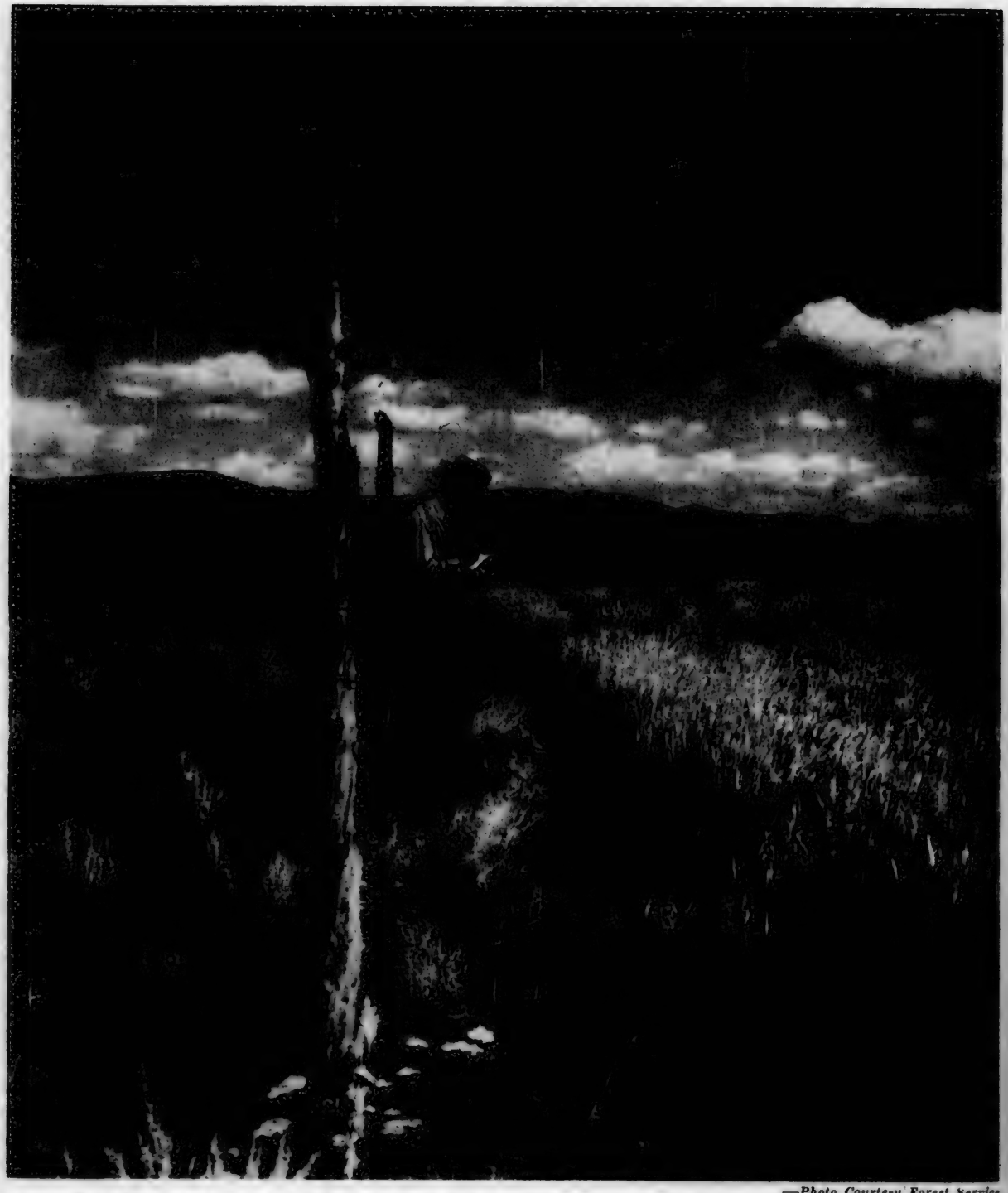
Table 2. Annual conservation expenses per tillable acre in farm, farms high in conservation and related improvements expenditures compared with farms low in conservation and related improvements expenditures, Madison and St. Clair Counties, 1939-48.

Items	10 High Farms			10 Low Farms		
	2-year averages			2-year averages		
	1939–40	1947–48	1939–48	1939–40	1947–48	1939–48
Expenditures per tillable acre						
Water control	$ .11	$ .15	$ .15	$ .00	$ .14	$ .04
Limestone	.45	.63	.48	.11	.55	.26
Phosphate	.09	1.16	.54	.05	.45	.17
Potash	.—	.11	.08	.—	.—	.—
Mixed fertilizer	.17	1.25	.63	.03	.47	.18
Total conservation expense	$ .82	$ 3.30	$ 1.88	$ .19	$ 1.61	$ .65



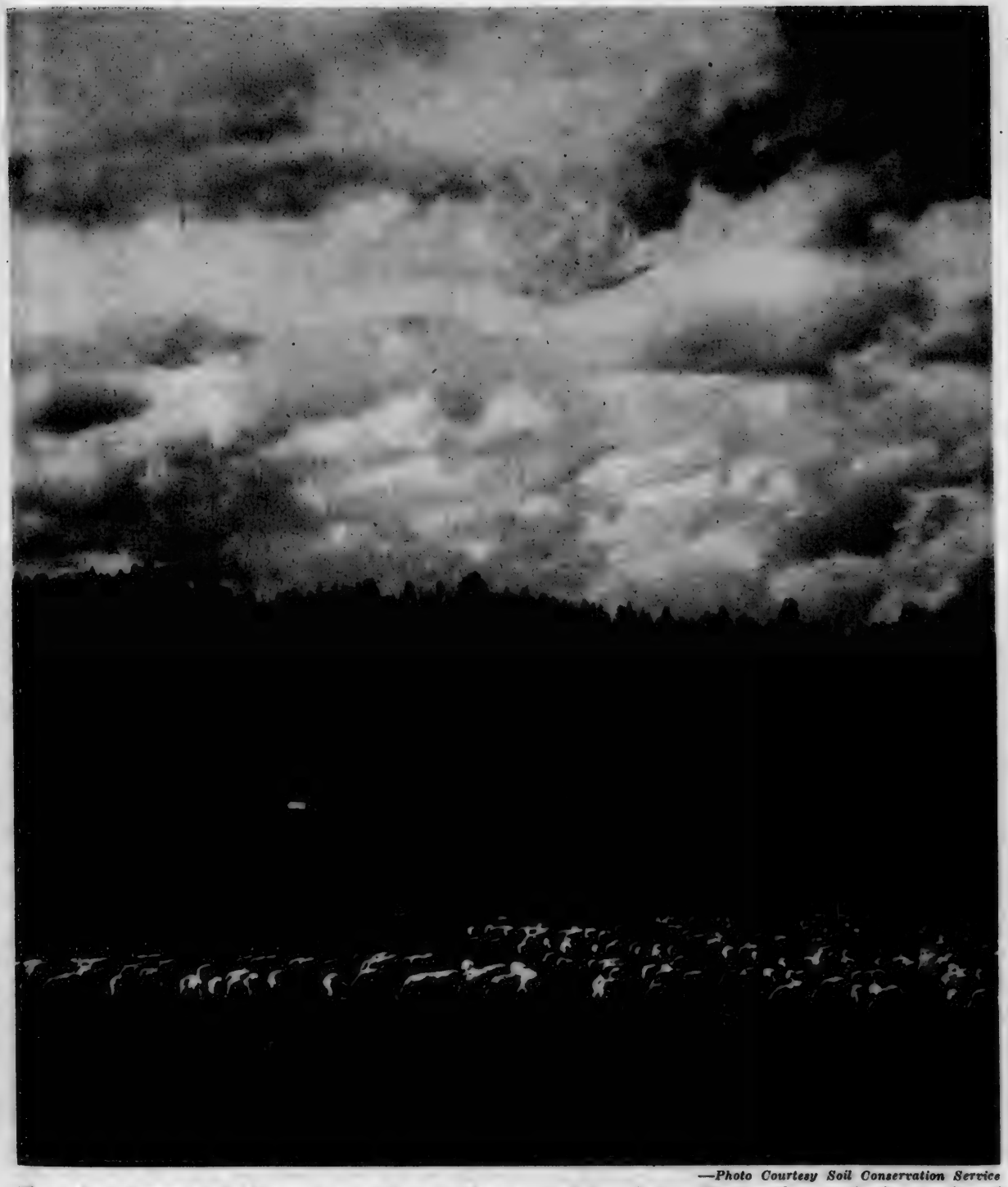
—Photo Courtesy Forest Service

A stream gaging station on the White River in Colorado during a period of high flow due to snow melting. The water is very clear from this commercially logged watershed.



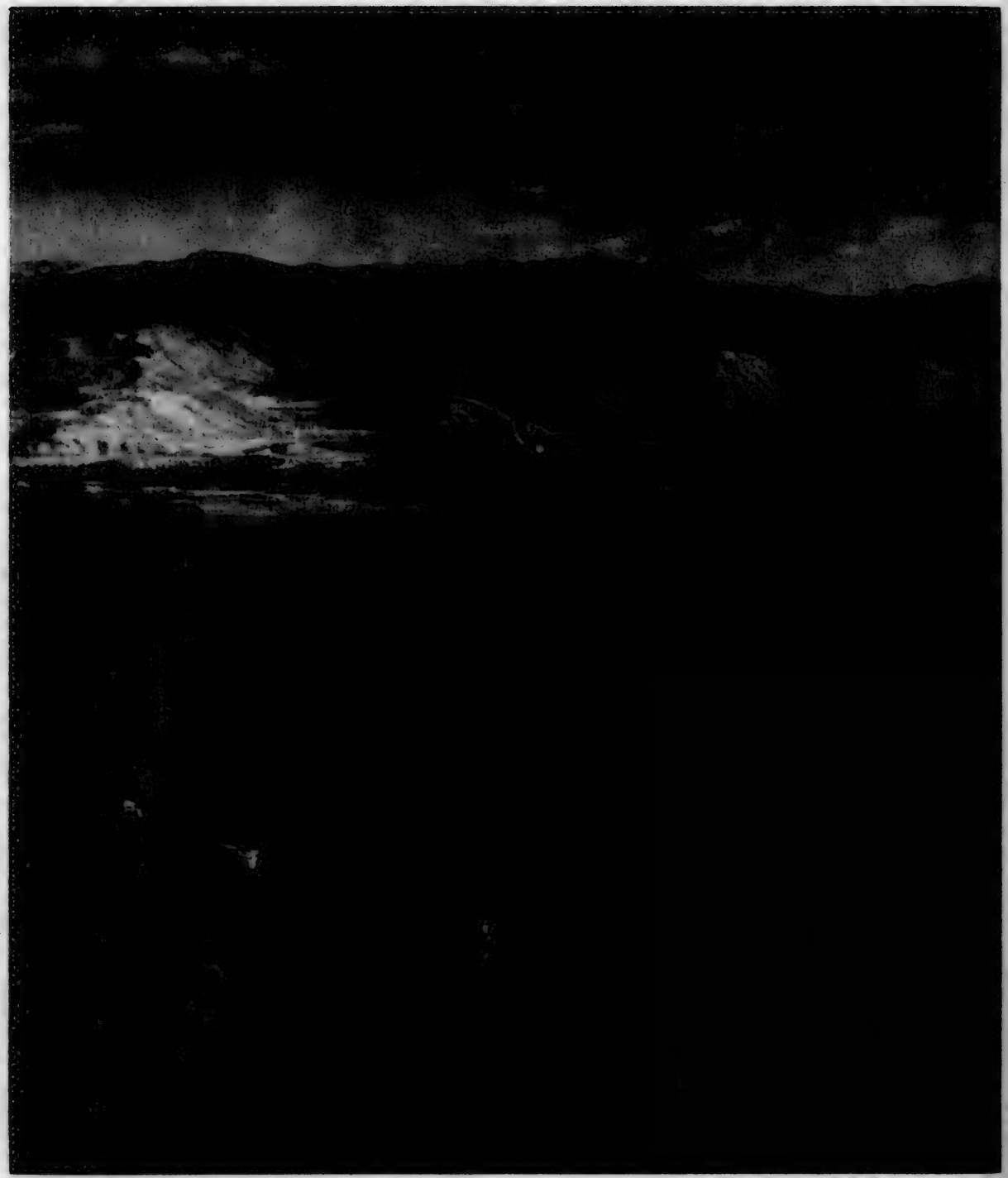
—Photo Courtesy Forest Service

This photo shows the difference in vegetative cover on a protected area, between low cheat grass and sage brush cover near the fence and crested wheat grass in the seeded area. Crested wheat grass is actually invading this low productive area and has already crossed the fence in many places.



—Photo Courtesy Soil Conservation Service

The productive capacity of this western grazing area has been restored through the utilization of proper land use and good range management practices—thereby making it possible to produce livestock more cheaply.



—Photo Courtesy Soil Conservation Service

An irrigated valley as viewed from Teten Pass in the West. Great potentials lie ahead in this section of the country in some further expansion of irrigation and in improved utilization of its water resources for irrigation and other purposes.

Table 3. Yields of grain crops, farms high in conservation and related expenditures compared with farms low in conservation and related expenditures, Madison and St. Clair Counties, Illinois, 1939-1948.

Item	10 High farms			10 Low farms		
	2-year averages		10-year average	2-year averages		10-year average
	1939–40	1947–48	1939–48	1939–40	1947–48	1939–48
Average yields (bushels per acre)						
Corn	55	50	49	51	44	47
Oats	35	35	33	41	33	33
Wheat	28	26	23	24	23	22
Soybeans	23	20	21	14	22	20
Crop yield index [1]	98	104	102	96	94	95

[1] Average yields for all 48 farm account record keeping farms in Madison-St. Clair counties equals 100.

change in oat yields over the period, but on the low farms oat yields fell from an average of 41 to 33 bushels per acre. The wheat yields for the high farms fell from 28 to 26 bushels per acre, while on the low farms wheat yields fell from 24 to 23 bushels per acre.

The average soybean yield for the ten high farms over the ten-year period was 21 bushels per acre, compared with 20 bushels for the ten low farms. The crop yield index, comparing average yields of all crops on the two groups of farms, shows a substantial relative increase in yields on those farms having the highest expenditures for conservation and related improvements.

Grain production. A measure of the average total grain yields for the two groups of farms is given in Figure 3. The ten high farms averaged 3.1 tons of grain (corn, oats, wheat, soybeans, barley) more per 100 acres of farm for the ten-year period than the ten low farms. The yields of hay showed an even greater difference. The ten high farms averaged 5.5 tons of hay per 100 acres of farm more than the ten low farms. In percentage terms, the ten high farms produced seven per cent more grain per 100 acres of farm, and 28 per cent more hay per 100 acres of farm. The contrast in production shown by these figures is even greater than the comparison of yield figures or the comparison of yield index figures indicated.

This greater yield per 100 acres on the high-conservation farms results partly from the fact that these farms had less idle land per 100 acres. The land on the high-conservation expenditure farms that was not arable, such as land in wet spots, was brought into cultivation by drainage; and lands which were under cultivation were not allowed to be lost for farming purposes by erosion, gullying, becoming and staying wet, etc. On the ten high farms the yields per acre were higher, the productive capacity was not only maintained but increased, and more land was brought under cultivation rather than lost to cultivation.

Fertilizer Use Increases Production and Income

Some of the high conservation expenditure farms were just beginning a more intensive fertilization program including the use of mixed fertilizers and nitrogen, when the farm record study, on which this analysis is based, was terminated. In the last two or three years, some of the high-conservation farms have had tremendous increases in yields as a result of a heavy fertilization program combined with other parts of a complete conservation plan. To illustrate, a striking example of the value of fertilizers in wheat production on one of the high farms was observed in 1952. One-half of a forty-acre field (uniform soil with same previous treatment) received 350 pounds per acre of mixed fertilizer at seeding and a top dressing of nitrogen early in the spring. The other 20 acres were not fertilezed. They yielded 20 bushels per acre. The fertilized wheat yielded 38 bushels per acre. The fertilizer cost $11.50 per acre. At $2.00

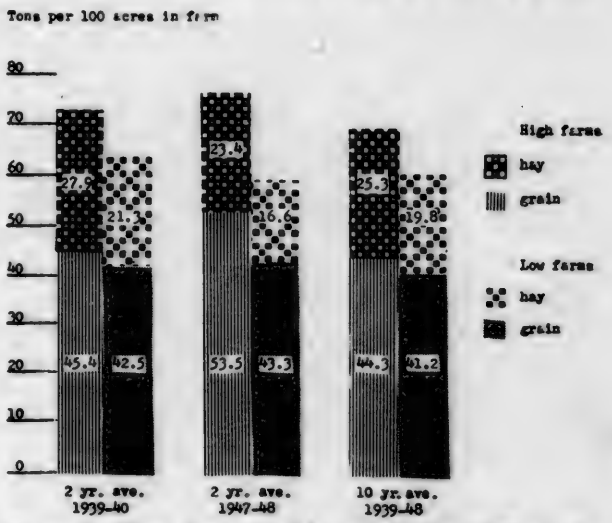


Figure 3.—Tons of grain and hay produced per 100 acres in farm, high and low expenditure farms, beginning, end and average of period 1939-48.

per bushel, the increased yield of 18 bushels was worth $36.

Livestock production. The livestock enterprise showed the same results as did the crop yields (Table 4). Livestock returns were closely related to the quantity and quality of feed (grain and forage) produced on the land. The farms with higher conservation expenditures produced higher crop yields, both grain and forages, and thus supported a larger and more efficient livestock enterprise.

For the ten-year period, the ten high-conservation farms fed 18 per cent more feed per acre to their livestock and received 20 per cent higher returns per $100 feed fed than did the ten low farms. With a less favorable livestock-feed ratio, their return per $100 feed fed fell $5.00 in the ending two-year period while the ten low farms had a decline of $22.00 per $100 feed fed in the ending two-year period.

A consistently higher percentage of the income of the ten high farms was from livestock compared with the ten low farms.

The ten high farms produced an average of 1800 pounds more meat per 100 acres and had higher average livestock sales per acre for the ten-year period.

Over the ten-year period, the proportion of concentrate-consuming animals was reduced appreciably compared with the roughage-consuming animals. The relative amounts of hay and pasture produced were increased, as were the returns of manure to the land. The net effect of these changes was a sounder soil conservation farming program with increased yields of crop and livestock products.

The ten high-conservation expenditure farms produced an average of 118 cwt. more milk per year per 100 acres compared with the ten low farms (Table 4). Milk production averaged (8,757) pounds per cow per year for the ten high farms, and 6,598 pounds per cow per year for the ten low farms. Better quality and larger quantities of mixed legume hay and pasture were, at least in part, responsible for the higher milk production per cow on the high-conservation farms. The ten high-conservation expenditure farms received an average of $100 per year more per cow milked than did the ten low-conservation expenditure farms.

While the ten low-conservation farms increased the number of cows per hundred acres during the ten-year period, the ten high-conservation farms increased production per cow and per 100 acres over the ten-year period.

The pay-off. For the entire farm enterprise, the ten high-conservation expenditure farms received an average net income return of $8.36 more per acre per year for the ten-year period (Figure 4).

The rate of return was higher and advanced more for the high-conservation farms. On the basis of a 160-acre farm, the high-conservation expenditure farms had annual net returns of $585 more per farm than the low-conservation expenditure farms for the two years 1939-1940 and $2,496 more for the years 1947-1948. Their ten-year average advantage in earnings of $8.36 an acre would amount to $1,337 annually for a 160-acre farm, or an advantage of over $110 per month.

Conclusions. The answer to the question "Does it pay to invest money in soil conservation and related farm improvements under ordinary farm conditions?" is an emphatic yes. It paid to invest money in soil conservation and related farm improvements under ordinary farm conditions in 1939-48. The high-conservation farms had an average expenditure for conservation mea-

Table 4. Livestock production, farms high in conservation and related expenditures compared with farms low in conservation and related expenditures, Madison and St. Clair Counties, 1939-1948.

Item	Ten high farms			Ten low farms		
	2-year averages		10-year average	2-year averages		10-year average
	1939–40	1947–48	1939–48	1939–40	1947–48	1939–48
Feed fed per acre	$ 8.32	$ 26.36	18.32	$ 5.84	$ 24.42	$ 15.54
Returns per $100 feed fed	$189.	$184.	$190.	$177.	$155.	$160.
Per cent income from livestock	63	77	77	54	74	72
Animals per 100 acres						
Cattle	15	13	15	11	10	12
Hogs	23	15	22	16	16	19
Chickens	149	114	136	86	112	105
Livestock production per 100 acres						
Milk, cwt.	417	444	468	331	319	350
Meat, cwt.	92	469	98	62	68	80

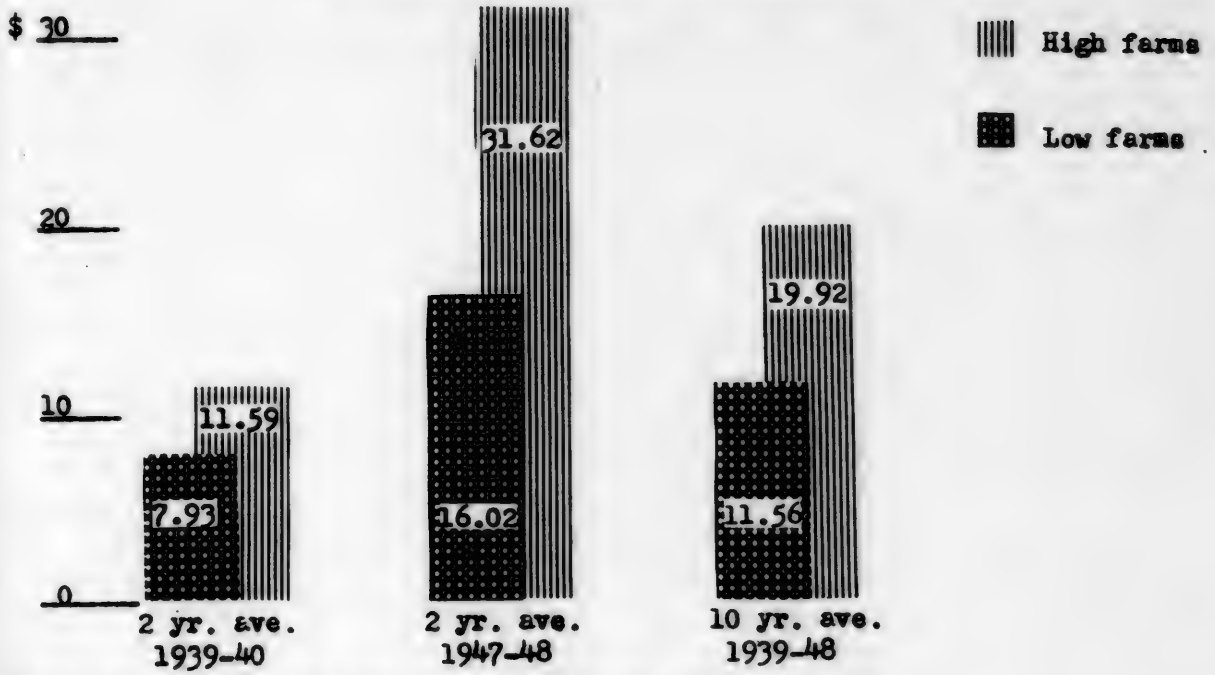


Figure 4.—Comparison of net farm income per acre on high and low conservation expenditure farms, beginning, end and average of period 1939-48.

sures of $1.41 per acre more for each year of the ten year period. They also spent $5.68 an acre a year more for buildings, equipment and livestock to implement the conservation plan. Because of higher grain, hay and pasture production, the volume of business was greater, more livestock and livestock products were produced, and more money was earned by the high-conservation farms. These farms had an average *net income* of $8.36 per acre more for each year of the ten-year period. Thus for an additional investment of $7.09 per acre, the high-conservation expenditure farms realized a *net income* of $8.36 more per acre or a 72 per cent increase in net income. In other words there was a return of 218 per cent on expenditure for conservation and related improvements—each $1.00 invested increased net income sufficiently to pay for the investment and return an additional $1.18.

The adoption of a complete soil conservation plan, which, of course, includes sound land use and fertility improvement, is the soundest and most effective way for farmers to increase farm production and farm income. On many farms investment in a soil conservation and fertility improvement program will show greater returns over the years than any other use of capital.

Conservation means more than putting the brakes on use of field crops, trees and minerals. The conservationist is not a hoarder, but a person who makes judicious choices. He has three general principles. In the first place, he applies resources primarily to those uses for which they possess particular qualifications: for example, crude oil can either be burned under a boiler in competition with coal or, when refined into gasoline, be used in ways with which coal cannot compete. In the second place, he prefers to use continuing or recurring resources instead of fund resources: vegetation, water and sunshine instead of minerals, when such a substitution is economically feasible. And in the third place, he tries to protect his sources of supply.
—From the Royal Bank of Canada Monthly Letter. September 1952.

Improving Land Conditions For Conservation And Production with Chemical Soil Conditions

R. W. PEARSON AND V. C. JAMISON

IMPROVEMENT IN THE PHYSICAL condition of soil has from time immemorial been accomplished by the use of organic amendments and of rotations that include sod or other close-growing crops. No very effective rapid means of improving soil structure was known prior to the announcement of a synthetic soil conditioner by the Monsanto Chemical Company. Since that time, however, the public has been subjected to a deluge of claims of benefits to be derived from the use of products that were hastily thrown on the market in an attempt to cash in on the wave of enthusiasm that followed the original announcement. Unfortunately, some of these claims have far exceeded the possibilities of soil conditioners. Furthermore, in some cases materials that may be capable of improving soil structure have been marketed before the most effective means of using them had been determined. The wide-spread and continuing interest among capable soil scientists and chemists, however, gives promise that a sound body of information should be on hand soon to help clear up some of the confusion that has resulted from the extremely rapid development in this new field. Several preliminary studies have been reported or reviewed 1, 3, 5, 6, 8, 9, 10.

The purpose of the present paper is to answer the four following questions in the light of information that is currently available:

1. What are chemical soil conditioners?
2. What can they do?
3. What can't they do?
4. What are some of their practical applications?

What They Are

The results of a recent count of individual products currently marketed as soil conditioners showed that there were 28 and the list will undoubtedly continue to grow. Actually, these materials all belong to one of three classes of chemical compounds: 1. Polyvinylites, 2. Cullulose gums, and 3. Lignin derivatives. Nearly 90 per cent of the commercial products now available belong to the Polyvinylite group, and practically all of this class of materials is produced by two chemical manufacturers and packaged for sale under different trade names. Also, the product is often diluted, thus reducing the amount of active ingredient. In the list of commercial products mentioned above the active material ranges from as low as 15 per cent to as high as 98 per cent.

What They Can Do

The mechanism by which the synthetic conditioners improved soil structure has not been clearly explained, but it is probably much the same as in the case of the naturally occurring polyuronides formed in soils during bacterial decompositon of organic matter. At any rate, they have only one direct effect on soil structure—increased aggregate stability.

It has been shown conclusively that the conditioners[1] can increase the stability of soil aggregates, and this, of course, is the first requisite for good physical condition. The aggregates must be able to survive the destructive effect of rain and tillage machinery to be of much value. However, it should be noted here that the application of conditioners results in the stabilization of whatever soil structure exists at the time of application. This means that large clods can be made less susceptible to slaking down if such a conditon exists when treated with conditioners. It has not been shown yet whether conditioners can influence aggregate formation. Most of them are anions (7), and therefore not effective as flocculating agents.

As a result of increased aggregate stability, a number

Table 1. Changes in Total Pore Space in Three Soils Resulting from the Application of CRD-186.

Soil	CRD-186 Added	Total Pore Space
	lb./acre	cc/100 cc
Hiwassee sandy loam	0	43.6
Hiwassee sandy loam	500	50.8
Decatur silty clay loam	0	47.5
Decatur silty clay loam	2000	57.0
Vaiden clay	0	57.0
Vaiden clay	4000	60.8

[1]CRD-186 and CRD-189 are laboratory research numbers for the Montanto Chemical Company products.

This paper, a contribution from the Division of Soil Management and Irrigation Agriculture, Bureau of Plant Industry, Soils and Agricultural Engineering, was presented at the annual meeting of the SCSA held in Buffalo, New York, October 23-25, 1952. R. W. Pearson, Senior Soil Scientist and V. C. Jamison, Soil Scientist, are located at Auburn, Alabama.

of other important soil characteristics are changed. Among these could be listed aggregate size distribution, microbiological activity, rate of water evaporation, infiltration rate, aeration, and surface crusting. Only the last three of these will be commented on in more detail at this time.

Probably the most important of the indirect effects is increased infiltration rate permeability. The results of a number of experiments have demonstrated that, as would be expected, infiltration is increased by the use of conditioners on fine textured soils or soils that tend to crust. Since rainfall is often inadequate to meet maximum crop requirements in those parts of the country where infiltration is a problem, any improvement in the ability of the soil to absorb the water that falls on them would mean effectively increasing the water available for crop production. By the same token it would mean less water to run off the surface and cause destructive erosion. An outstanding example of a problem area of this type is the Piedmont section of the Southeastern United States.

Soil permeability is also increased by additions of conditioners. It should be noted, however, that this effect would only occur in the soil zones to which the material has actually been added. Thus, if conditioners are mixed in a restrictive layer the rate of water movement through the entire profile might well be increased and thus internal drainage of the soil improved. However, if restricting zones exist below the layer in which the material is mixed there would be little or no improvement in profile permeability.

It should be pointed out that while increasing the infiltration and permeability of a soil is generally a highly desirable objective, under some circumstances deleterious effects can result. Damage to crop seedlings from herbicides can result from increased penetration of these materials following the use of soil conditioners. This situation has been encountered in several instances already.

Aeration is improved by soil conditioners through the same mechanism that produces better permeability. The addition of soil conditioners to medium or fine textured soils invariably causes an increase in total pore space, as illustrated in Table 1. However, this is only part of the story. It is important to know what is the size range of the pores represented by this increase. The results illustrated in Figure 1 indicate that only the large or macropores are appreciably affected. Samples of Lloyd clay, with and without additions of Krilium, were lightly packed, or heavily packed, and then the moisture content determined over the entire range of 0 to 15 atmospheres of soil moisture tension. In both cases the curves

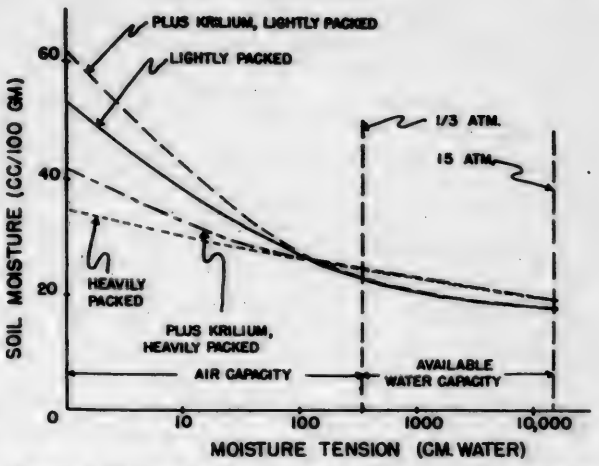


Figure 1. Effect of soil conditioner and degree of compaction on air capacity of Lloyd clay.

were practically coincident at tensions above 1/3 atmosphere, showing that the treatment had not affected the very small pores. At tensions below 1/3 atmosphere, however, the addition of Krilium increased the amounts of water held by the soil, showing that there had been an increase in the large pores. Thus, as the proportion of large pores increases due to soil conditioner additions, drainage becomes freer and a larger portion of the soil mass is occupied by air.

As a result of improved aeration there will be increased microbiological activity in soils with restricted aeration that have been treated with soil conditioners. This might well result in a lowered equilibrium level of soil organic matter and nitrogen which, of course, would be accompanied by the release of a certain amount of nitrogen in nitrate form. Although there are as yet no data on the magnitude of this effect in different soils, results reported by Hedrick and Mowry definitely show increases in microbiological activity in soils treated with conditioners and to which were added a source of energy. It should be noted, however, that the microflora could be stimulated to greater activity through the direct effect of certain soil conditioners, such as some of the cellulose gums, as energy sources themselves.

One of the most promising effects of the synthetic soil conditioners is their ability to decrease surface crusting of soils. Although this is involved to some extent in the question of changes in infiltration rate, it is also important in its effect on seedling emergence. In most areas there are soils which, due to their textural and structural makeup, have a tendency to form hard surface crusts. These crusts are often capable of preventing the emergence of crop seedlings. The work of Allison (1) with saline and alkali soils and of Hedrick and

Mowry (3) and others with acid soils has shown that this effect can be prevented by the proper use of soil conditioners.

Finally, soil conditioners should be capable of causing decreased losses of soil moisture by evaporation. This would be accomplished through exactly the same mechanism that decreases evaporation under a mulch. The increase in large pores in the surface treated zone of soil would slow capillary movement to the surface. In addition an insulating layer is formed which should result in somewhat lower soil temperatures during hot weather.

The net effect of these modifications of various soil characteristics on plant growth have been shown in a number of field and greenhouse experiments. Increases in yield of corn, sugar beets, turnips, potatoes, carrots, and oats and marked decreases in soil and water loss have been found to result from the use of conditioners on heavy soil. Extensive screening studies have been made of new materials, and the most promising ones selected for more detailed study under field conditions. Tests of this kind are now under way at Auburn, Alabama and State College, Mississippi. Preliminary results show that the relative rating of the different materials varies somewhat with predominant clay mineral type, soil textural class and moisture conditions at time of application. In general, however, the order of effectiveness appears to be polyvinylites>cellulose derivatives >silicates>lignin derivatives. It should be emphasized that this order is tentative and that certain products have proved more or less effective than the rating assigned the class to which they belong. One interesting point in this connection is the fact that sodium silicate is fairly effective in small applications, but poor at high rates. This appears to be due to the dispersing effect of the sodium which counteracts the tendency of the silicate to stabilize aggregates. An emulsion of ethyl silicate is quite effective if used in very large guantities, i.e., 5 or 6 times the amounts of Krilium required.

What They Cannot Do

Let us now consider briefly some things that soil conditioners cannot do and about which there have been erroneous or confusing claims. First, soil conditioners are not fertilizers and cannot replace fertilizers in promoting plant growth. As a general situation we will undoubtedly continue to get much larger plant responses from addition of plant nutrients than from the use of any quantity of soil conditioner.

Second, they cannot permanently affect the nutrient supplying capacity of soil. A possible exception to this statement would be the case of potassium in very poorly aerated soils since it is known that the availability of potassium is usually lower in poorly aerated soils than in soils of good structure. It was pointed out earlier that some increase in nitrate nitrogen in the soil might result from stimulation of the soil microflora through the improvement of aeration following application of soil conditioners. This would be a temporary condition lasting only until a new equilibrium level of soil organic matter and nitrogen had been established.

Third, soil conditioners cannot affect aggregation by being simply spread on a fine textured, compact soil. Indeed, such use of these materials might well result in the stabilization of a very undesirable type of structure. Although claims are made that some of the products now being offered may be applied directly to the surface of a compact soil, and will have their full effect without mechanical stirring either before or after additions, the experience of most workers who have experimented with these materials indicates that this procedure is not satisfactory.

The last and most important point to be made is that the soil conditioners cannot cause an important increase in the available waterholding capacity of soils. The exception to this statement would be very coarse textured soils having extremely low capacities to store available water. In such soils the simple dilution of a very droughty material with large quantities of the organic conditioner, which in itself has a fairly high available water capacity, could cause an apparent increase in the soil's ability to hold available water. For those highly effective conditioners which are added in low concentrations, this effect would not be measurable. Data have already been presented for Lloyd clay showing that the changes in pore space in this soil resulting from the addition of Krilium were in the macropore rather than the micropore range. Since there was practically no change in the ability of the soil to hold moisture above the 1/3 atmosphere tension point it is obvious that the increased capacity to hold water is only in the free drainage range and thus would not constitute available water.

The rather commonly held but erroneous ideas regarding the effect of improved structure on water storage capacity of soils probably arises from confusion of the earlier term "water holding capacity" with "available water capacity." Water-holding capacity of soils was generally determined by allowing a saturated sample to drain under the force of gravity and then determining the amount of moisture contained in it. The tension head under these conditions was so small that practically all of the pores remained saturated with water and the procedure simply measured most of the pore space rather

Table 2. Air-Water Relationship in Three Soils as Affected by Additions of CRD-186

Soil	CRD-186 added	Air Capacity	Av. Water Capacity	Wilting Point
	lb./a.	cc/100 cc	cc/100 cc	cc/100 cc
Hiwassee sandy loam	0	30.3	5.4	8.0
Hiwassee sandy loam	500	38.7	3.4	7.4
Decatur clay loam	0	18.3	16.6	12.4
Decatur clay loam	2,000	33.5	11.7	12.9
Vaiden clay	0	33.2	6.7	17.1
Vaiden clay	4,000	38.5	5.2	17.1

than the soil's available water-holding capacity. If, instead of allowing the samples to drain, they had been placed in contact with a relatively deep column of medium textured soil they would have drained to a steady state approximating field capacity; this is the condition found in soils in the field within a few days after having been wetted to saturation. The soil moisture tension at this point is approximately 1/3 atmosphere and that at the point where plants permanently wilt is about 15 atmospheres. Moisture contained by soil between these two points is now generally accepted to represent the available water-holding capacity of a soil.

The data quoted earlier in Table 1 showing a marked increase in total pore space for three soils may be interpreted as indicating an increase in the capacity of these soils to retain available moisture. That this would be an erroneous conclusion is shown by the breakdown of the total pore space as given in Table 2. In every case the conditioner increased the air capacity of the soil, which is the pores drained at 60 cm. of water tension, and the amount of this increase was in the same order of magnitude as the increase in the total pore space indicated in Table 1. At the same time there was a slight increase in the very small pores as indicated by the fact that the wilting point in each soil was increased slightly. The net effect of this treatment was a significant though relatively small decrease in the ability of the soils to hold moisture in a form available to plants.

The general proposition that the available water-holding capacity of soil decreases with improved structure is further borne out by the data of Table 3. Check samples of Lloyd clay and samples previously treated with Krilium were subjected to the various compaction and puddling treatments indicated. The light compaction treatment was obtained by applying 2.25 pounds per square inch at 60 cm. tension and the heavy compaction was obtained by ten successive tractor tire passes at about field capacity moisture with a vertical load of 2185 pounds. Puddling was accomplished by crushing and stirring samples saturated with moisture until no sign of aggregates could be observed. Compaction decreased the air capacity of macropores and increased the moisture held at the wilting point quite markedly. Puddling the soil had the same effect, reducing the air capacity of the untreated soil to only 7.9 per cent. The addition of Krilium modified this effect a great deal, giving the soil an increased bearing capacity and making it resistant to puddling. However, the available water-holding capacity of the soil was in every case increased as the degree of aggregate destruction increased showing the highest value in the puddled and undried soil.

These data simply show that after equilibrium has been reached in the field following saturation with water, less moisture available to plants will be held in a soil with good structure than in one with poor structure. At the same time it should be emphasized that the overall picture of soil water-plant growth relationships is usually improved by improvements in structure. This is true because the soil's ability to absorb the water that falls upon it is increased with increased aggregate stability which prevents surface sealing. In many areas where erosion is a serious problem rains often occur in short heavy showers and improvements in the soil's ability to absorb water would be especially important. Also, as mentioned earlier, loss of moisture through evaporation is probably decreased in soils of good structure. These two beneficial effects on soil moisture relationship will usually counteract any decreases in available water-holding capacity, and the net effect of improved structure would be less soil and water loss and more moisture available for crop production.

Table 3. Effect of Changes in Structure of Lloyd Clay on Soil-Air Water Relationships

Treatment	Air Capacity	Av. Water Capacity	Wilting Point
	cc/100 cc	cc/100 cc	cc/100 cc
Light Compaction	33.0	5.9	19.7
Heavy Compaction	3.2	7.1	27.7
Puddled, undried	7.9	13.8	30.1
Puddled, dried, light compaction	26.9	7.3	21.9
Krilium[1] + light compaction	38.7	5.6	18.0
Krilium + heavy compaction	20.6	7.4	24.3
Krilium + puddled, undried	11.5	12.8	28.8
Krilium + puddled, dried, light compaction	31.4	7.3	21.3

[1]2,500 lb. of CRD-186 per acre six inches.

Practical Application

Before considering possible practical application of the soil conditioners let us look at some of the problems involved in their use. The first of these is the proper application and incorporation of the material in the soil. They apparently cannot be simply spread on the soil and left with the certainty of obtaining satisfactory results. For best results they should be applied to a prepared seedbed, thoroughly mixed with the soil, moistened and then stirred again. Of course, if the material is mixed in a soil containing sufficient moisture to dissolve the conditioner, one step can be eliminated. The moisture content of the soil at time of application is important. Results from several locations show that if the material is applied to a wet soil large resistant clods are formed in and on the soil surface. Also, if it is diluted too much it may be distributed through too large a part of the soil mass and the effective concentration will not be great enough to cause the desired effect. The problem of thoroughly mixing the materials with the soil is now being studied by the Division of Soil Management and Irrigation and the Division of Agricultural Engineering, ARA, in an attempt to determine what types of available tillage implements are capable of doing the best job. Some of these tests have used radioactive phosphorus applied to the surface and incorporated by use of a number of common tillage implements. Subsequent determination of the distribution of the radioactive material in the soil is used as a criterion of effectiveness of mixing. Although few quantitative data are yet available on this problem, the observations of a number of workers in the field indicate that such operations as disking and harrowing are very ineffective ways of mixing the material in soils. Of course, many special problems will arise such as dense soil layers below the plow depth where ordinary means of mixing would not be applicable.

Another problem that has been touched upon but has yet to be satisfactorily answered is the question of persistence of the improved structure brought about by use of soil conditioners. Laboratory studies conducted by Hedrick and Mowry (3) indicate that the Polyacrylates are quite resistant to bacterial attack. This should also be true of the other type materials with the exception of the unsubstituted cellulose gums. Hercules Company's CMC 120-High, which has 40 per cent of the available positions substituted by carboxymethyl groups has been reported to be quite resistant. Furthermore none of these materials should leach appreciably, so that once the reaction with the soil has been completed no appreciable loss in this way should occur. Although aggregate stability is increased to a marked degree by the soil conditioners, some destruction would certainly follow the normal operation of tillage implements and the compacting effect of machinery. We do not know yet what the extent of these effects may be, although some preliminary data have been reported. The results reported by Martin et al (4) show that no appreciable reduction in the percentage aggregation of Miami silt loam was found in the field one year after application of soil conditioners. Much more information will be needed on this problem, however, before a decision can be reached as to how often application of soil conditioners will have to be repeated.

Finally, cost should be mentioned in connection with the practicability of these materials for field use. Nason (5) recently reported that the cost of treatment with various products now on the market, using their recommended rate of application, varies from 50c to as high as $7.90 per 100 square feet. On an acre basis this would range from slightly over $200 to more than $3,000; however, some of the materials now being tested could be applied at considerably lower cost if they prove to be reasonably effective in producing good structure. Also, these figures are based on treatment of the plow layer. It would appear that at present prices and with the extra tillage operations required for incorporation of the soil conditioners, their use in the field with ordinary crops for the improvement of structure in the entire plow layer would be economically impracticable. However, there seems to be a definite possibility that these materials could be used to advantage in very small amounts applied to the surface of the soil to prevent crusting and sealing. In this way less than 100 lbs. of material would be the equivalent in its effect on the surface to a 500 lb. application mixed in the plow layer. Data have already been quoted showing that this procedure can be quite effective in increasing germination and emergence of different crops. At the same time loss of soil and water by runoff would be substantially decreased.

Another practical application of conditioners that would seem to have possibilities is the use of these materials in narrow bands immediately above the seed in the case of row crops. This procedure, again, would be a means of decreasing the amounts of material required and at the same time obtaining maximum benefits in the immediate area of the plant. Such use would, of course, pose problems as to how the application and mixing of the material could be satisfactorily accomplished and what loss would result in control of runoff and soil erosion. Additional study is needed on this problem.

Control of erosion is an important field for the use

of soil conditioners. In the process of insuring better germination and emergence of crop seedlings, decreased runoff and soil loss is accomplished in cultivated fields through elimination of surface crust. There are, in addition, a number of situations where erosion is an especial hazard and the use of soil conditioners should prove most effective. A good example is provided by the problem of protecting newly established waterways and terrace outlets. During the period between construction and the establishment of a sod cover these structures are particularly vulnerable and the use of soil conditioners would give a considerable amount of protection. In such cases certain of the cheaper materials that are less resistant to bacterial decomposition should be quite satisfactory, since erosion would be under control once the sod has been formed.

Road cuts and fills and ditch and canal spoil banks also present vexing problems of holding the soil in place until a protective cover of vegetation can be established. Results of studies by Martin et al (4) and by Weeks and Colter (9) show that Krilium gave good control of erosion on freshly prepared slopes simulating fills, although it was generally somewhat less effective than a straw mulch.

Throughout the Piedmont region of the Southeastern United States there are numerous eroded areas locally called "gall spots" which are usually quite unproductive. The productivity of these spots can be built up over a period of time by careful management including use of generous applications of organic materials. It would appear that the use of soil conditioners on these areas might significantly increase the rate at which they can be brought into full productivity.

Another interesting application of the soil conditioners is in the reclamation of saline and alkali soils. The usually high content of exchangeable sodium in these soils causes aggregate disintegration with all the attendant problems of moisture infiltration and of drainage. Reclamation of such soils requires the removal by leaching of a portion of the sodium, but since water movement in dispersed soil is usually very slow, the process is severely handicapped and may be quite expensive. Thus, a material that could restore good structure to these soils would have a wide application in the arid regions, even though the improvement in stucture should prove to be temporary. Allison (1) has studied this problem in considerable detail and found that both CRD-186 and 189 were quite effective in producing water stable aggregates and in increasing water infiltration and permeability. Results from his study, listed in Table 4, show that the conditioner caused a very large increase in infiltration in both non saline-alkali and in saline-alkali soils during the first irrigation after treatment. After eight irrigations there was still a marked effect, although the total intake was much lower. As would be expected from the increase in infiltration, Allison found that after the eight irrigations a great deal more salts and exchangeable sodium had been removed from the surface soil in the conditioner-treated plots than in the untreated ones.

Table 4. Effect of Soil Conditioner on Infiltration Rates of Saline and Alkali Soils*

Treatment	Infiltration rate—in/hr.		
	Non saline-alkali soil	Saline-alkali Soil No. 1	Saline-alkali Soil No. 2
	1st Irrigation (2, 5 in. of water applied)		
Check	1.3	.16	.35
2,000 lb. CRD-186	6.2	6.2	5.6
	8th Irrigation (2 to 3 in. of water applied)		
Check	.18	.05	.06
2,000 lb. CRD-186	4.0	.53	.50

*From data of L. E. Allison (1).

Summary

On the basis of rather short term field and laboratory tests it has been definitely shown that certain of the proposed soil conditioners can produce marked improvement in the physical condition of fine textured compact soil when properly applied at sufficiently high rates. To-date the polyvinylites and cellulose gums appear to be most effective on a wide variety of soils. Wide-spread use of these materials in the field is limited at present by their cost, incorporation requirements, and lack of information on persistence of their effects. However, they do have practical application for many special purposes and for use with high value crops.

LITERATURE CITED

1. Allison, L. E. 1952. Effect of synthetic polyelectrolytes on the structure of saline and alkali soils. Soil Sci. 73: 443-454.
2. Coleman, N. T. Personal communication. 1952.
3. Hedrick, R. M. and Mowry, D. T. 1952. Effect of synthetic polyelectrolytes on aggregation, aeration and water relationships of soil. Soil Sci. 73:427-442.
4. Martin, W. P., Taylor, G. S., Engihous, J. C. and Burnett, E. 1952. Soil and crop responses from field applications of soil conditioners. Soil Science 73: 455-472.
5. Nason, Howard K. 1952, June 18. Let's look at the facts about soil conditioners. Address before the American Seed Trade Assoc. Annual Meeting, Detroit, Michigan.
6. Raney, W. A. Personal communication. 1952.
7. Ruehrwein, R. A. and Ward, D. W. Mechanism of clay aggregation by polyelectrolytes. Soil Sci. 73: 485-492. 1952.
8. Swanson, C. L. W. A new concept using chemicals for soil structure improvement. Jour. Soil and Water Conservation 7: 61-67. 1952.
9. Weeks, Lloyd E. and Colter, William G. 1952. Effect of Synthetic Soil Conditioners on Erosion Control. Soil Sci. 73: 473-484.

Mulches: An Important Item In Tropical Agriculture

JOSE VICENTE-CHANDLER

THE EFFECT OF MULCHING on soil conditions, crop growth and soil and water losses has been studied under a variety of conditions in the Temperate regions. Many of the basic relationships are well understood and much progress has been made in the development of the necessary complementary cultural and agronomic practices.

Much less is known about the effects of mulching under Tropical conditions. Indeed, this lack of information seriously handicaps the extension of a practice which may eventually play a more important role in the Tropics than it has in Temperate regions.

There are a number of questions that need to be answered under conditions that prevail in the Tropics: How effective are mulches in reducing evaporation losses of water from the soil surface? To what extent can mulches keep the soil cool under conditions of high sunlight intensity? What relationships exist between C:N ratios and the release and immobilization of nitrogen in Tropical regions where high rainfall and high temperatures further the rapid decomposition of organic material? To what extent can leguminous mulches be depended on to supply nitrogen for crop growth under these conditions? How long do different mulches last? To get specific information regarding these and other questions, several experiments were recently carried out in Puerto Rico by the cooperative research project "Erosion Control and Stable Crop Production in Puerto Rico."

The Effect of Mulches on Losses of Soil Water Through Evaporation.—An experiment was undertaken at Aguirre, on the South Coast of Puerto Rico, to determine the effect of a sugarcane trash mulch on soil moisture losses by evaporation. Twelve double-walled lysimeter tanks, three feet in diameter and four feet deep, filled with undisturbed field soil were used in this study. In each case the inner tank, containing the soil, was perforated to allow free drainage into the water tight outer tank. The tanks were buried in the ground with the tops flush with the surface. The soil in six of the tanks was kept covered with a sugarcane trash mulch. That in the remaining tanks was kept completely bare and free of weeds. Tensiometers and nylon electrical resistance units were installed at various depths in all the tanks so as to provide a continuous record of soil moisture conditions. The soil was wetted whenever it dried to a point about half way between field capacity and the permanent wilting point, at an eight inch depth. By carefully measuring the applied water, the rainfall, and water draining into the outer tanks, losses by evaporation over a five-month period were accurately determined. A weather station at the same location provided complete weather data.

During the course of the experiment the average maximum and minimum daily air temperatures were 86.6°F and 67.7°F respectively. Rainfall averaged 2.25 inches per month, wind about 50 miles per day and sunlight energy about 450 gram calories per sq. cm. per day.

The following table shows the average monthly evaporation losses of water from the different tanks. Open pan evaporation during this period averaged 5.62 inches monthly.

Water Lost by Evaporation
(expressed in inches per month)

Tanks No.	*Bare Soil*	*Mulched Soil*
1 and 2	1.76	1.04
6 and 4	1.90	1.00
5 and 3	2.20	1.00
7 and 11	1.58	.74
9 and 12	2.00	.68
10 and 8	3.30	.94
Average	2.12	.90

Mulching reduced this type of soil water loss by more than half. This loss was mostly of water already "stored" in the root zone for plant use. Considering normal water application efficiencies, this saving by mulches is equivalent to about three inches of irrigation water monthly, or almost one million gallons annually for every acre of land. This is an item worth considering in any program involving water conservation.

Nylon unit and tensiometer readings showed that the water lost by evaporation came mostly from the upper foot of soil. In the bare soil, the upper few inches dried out to beyond the permanent wilting point very quickly, while beneath the mulches even the surface soil remained relatively moist.

Jose Vicente-Chandler represents the Bureau of Plant Industry, Soils and Agricultural Engineering of the U.S.D.A. as supervisor of the research project—"Erosion Control and Stable Crop Production in Puerto Rico," which is cooperative with the Puerto Rico Agricultural Experiment Station.

The Effect of Mulches on Soil Temperatures. Soil temperatures were taken daily in all tanks at one inch, four inch, and seven inch depths at 7 A.M., 12 M., and 5 P.M.

The upper inch or so of bare soil heated up as much as 38°F during the day, frequently reaching temperatures of over 110°F. This temperature was often maintained over a period of many hours daily. The mulched soil did not vary in temperature more than 12°F daily nor did it go above 86°F. Moisture in excess of field capacity helped to keep the soil cool during the day.

The following table shows the average maximum daily variations in temperature at different depths in the mulched and bare soil throughout the course of the experiment.

	Depth in Inches		
	1"	4"	7"
Bare soil	24°F	15°F	9°F
Mulched soil	7°F	5°F	3°F

The effect of mulching in reducing variations in temperature and keeping the soil cool is evident down to the seven inch depth. Variation decreased with depth in the soil as would naturally be expected.

The Effect of Mulches on Surface Intake of Water: At the conclusion of the experiment under discussion, infiltration tests were run on the soil in eight of the tanks. In all cases but one, the rate was higher for the mulched soil. The average value for the mulched soil was 4.8 inches for the first half hour as compared to 3.2 inches for the bare soil.

The Effect of Mulches on Growth of Weeds: No weeding of the mulched soil was necessary either at Aguirre or in most of the other experiments mentioned later. In all cases the growth of weeds was greatly reduced. In the tropics, this advantage is very important. Weeds grow at an amazingly fast rate the year-round and even with repeated, costly cultivations they compete seriously with crops for moisture and nutrients.

The Effect of Mulches on Runoff and Soil Losses: Over a period of years the Soil Conservation Service kept records of soil and water losses from run-off plots with different treatments at Mayaguez, Puerto Rico. Data were taken from a summarization of this work by R. M. Smith, F. Abruna and F. G. Bell, which is in process of publication as a USDA-SCS Bulletin, to illustrate the effect of mulches on soil and water losses.

The run-off plots were located on 40 per cent slopes of Catalina soil, a typical, deep, acid, reddish tropical clay with a moderate to high intake capacity and moderate erodibility. Rainfall averaged about 80 inches annually with a well defined four month dry season.

Figure 1. Sugarcane, a major crop of the Tropics, produces its own heavy mulch. Here young cane shoots push their way up through the trash from the previous crop. This mulch is one of the main reasons why sugarcane is a good conservation crop. At Aguirre, on the dry South Coast of Puerto Rico, it has been shown that large savings of irrigation water can be achieved by protecting the soil with just such a mulch.

Table No. 1 shows clearly how maintaining sugarcane trash on the soil surface reduced soil losses as compared to burning this residue. This table also offers a comparison with grass cover and indicates that a mulch of sugarcane trash applied at the rate of five tons of dry matter per acre can be just as effective as grasses in reducing erosion losses under the conditions studied. On nearby plots mulching clean cultivated crops reduced soil losses by more than 80 per cent and resulted in 75 per cent less water lost as run-off.

Table 1.—The effect on erosion of keeping sugarcane trash on the ground surface as compared to burning over a four-year period at Mayaguez. Soil losses from plots of Molassesgrass are also shown. Each value is the average of six run-off plots on Catalina clay soil with a 40 per cent slope. Losses are expressed in pounds of dry soil per acre.

Year	Rainfall (inches)	Sugar cane (Trash burned)	Sugar cane (Trash used as mulch)	Molasses-grass
1944	69.7	19,710	1,560	—
1945	88.4	32,350	2,420	5,330
1946	71.4	6,210	930	330
1947	56.2	2,680	570	590
Average	71.4	15,240	1,370	2,080

As further evidence of the effectiveness of mulches in this respect, it might be mentioned that on deep, sandy soil on 60 per cent slopes at Utuado, a Kudzu mulch applied at the rate of five tons of dry matter per acre reduced soil losses from tobacco plots to 25 tons per acre during the tobacco season as compared to 90 tons lost from clean cultivated plots.

The Decomposition of Mulches and Nitrogen Release

Several experiments were carried out at Utuado, in the mountains of Central Puerto Rico. The elevation here is about 2,000 feet and annual rainfall averages about 80 inches. Air temperatures are slightly cooler than at Aguirre.

In one of the experiments at this location, tobacco was grown in plots located on bench terraces of deep, sandy Utuado soil. Various grass and legume mixtures were cut and applied green as mulches to these plots. All mulches were applied at the rate of five tons of dry matter per acre when the tobacco was transplanted. The undecomposed mulch material on the soil surface was sampled and analyzed periodically. The rate of decomposition and the amount of nitrogen released by the mulches was determined from these data.

In general, the mulches rotted away at the rate of about 30 per cent monthly, only about 20 per cent of the added material remaining on the ground three months after application. The mulches composed primarily of Tropical Kudzu decomposed at a somewhat faster rate than did the grass mulches due probably to the higher nitrogen content of the former. Throughout the course of the experiment the per cent nitrogen content and the C:N ratios of the undecomposed mulch material did not vary much from the initial values. The grasses averaged slightly above one per cent nitrogen (50:1 C:N ratio) and the Kudzu almost two per cent (25:1 C:N ratio).

The data relating to nitrogen release are summarized in Table No. 2. Large quantities of nitrogen were released by the mulches even at rather wide C:N ratios. The fact that the 100 per cent Kudzu mulch did not release more nitrogen is attributable to the higher proportion of old leaves and vines low in nitrogen included in this mulch.

In replicated trials repeated over two years at Utuado, Kudzu mulches provided all the nitrogen needed for high yields of tobacco. Plots mulched with 5 tons of Kudzu per acre and receiving no nitrogen fertilization consistently outyielded the clean cultivated check plots receiving 90 pounds of nitrogen per acre in the form of ammonium sulphate. Grass mulched plots with the same nitrogen fertilization outyielded the check plots and at no time did the tobacco exhibit signs of a nitrogen deficiency.

When Kudzu is allowed to decompose under conditions where leaching is largely prevented and is then applied as mulch it can quickly release large quantities of nitrogen for plant use. This was shown by an observational trial at Utuado. Tobacco was allowed to grow without nitrogen until it showed signs of a severe deficiency of this nutrient. Application of Kudzu mulch which had been partially decomposed in a protected area corrected all deficiency symptoms within a few days. Ammonium sulphate applied at the same time to neighboring plots had the same effect.

Table 2.—The release of nitrogen by different mulches over a ten-week period at Utuado. All mulches were applied at the rate of five tons of dry matter per acre.

Kind of mulch	Per cent nitrogen content	Lbs. of Nitrogen applied per acre	Nitrogen released	
			Pounds per acre	Per cent of total nitrogen applied
Guineagrass—25% Molassesgrass—75%	1.0	100	58	58
Guineagrass—70% Molassesgrass—30%	1.2	120	82	68
Unfertilized Merkergrass	1.3	130	96	74
Kudzu—60% Guineagrass—40%	1.7	170	101	59
Kudzu—70% Molassesgrass—30%	1.6	160	112	70
Kudzu—80% Molassesgrass—20%	2.15	215	148	69
Kudzu	1.7	170	118	70
Merkergrass fertilized with nitrogen	1.5	150	116	77

General Discussion

In large areas of the Tropics water is the limiting factor in crop production. Excessive rainfall seriously limits the possibilities of crop production over large areas. The fact that many regions of the Tropics suffer from a lack of moisture is less well known. Some of the most fertile soils of Tropical lands lie in regions where annual rainfall is low. Furthermore, in most of the Tropics there is a very marked dry season. Even where rainfall is well distributed throughout the year and abundant by temperate region standards, its effectiveness may be very low as conditions favorable to rapid evaporation exist the year round.

Mulches can help to conserve soil moisture in regions where it is scarce. By keeping the soil cool and by providing an effective barrier to the movement of water vapor they reduce evaporation from the soil surface. They also help to control weeds which grow rank the year round and waste large quantities of water which could otherwise be used by crops. Where mulching is not practised, frequent irrigations are necessary after seeding to keep the upper layer of soil cool and moist. These irrigations are usually wasteful as the lower layers of soil do not dry out and therefore cannot hold much of the water applied. Mulches keep the surface soil moist and cool, making frequent irrigations unnecessary.

In areas where rainfall is abundant during some periods, yet scarce at others, mulches can help in utilizing it more effectively. By increasing intake rates they make it possible for the soil to store more water for use by the plant during the dry season. Mulches help in various ways to keep intake rates high. They maintain conditions favorable to biological activity at the soil surface. The activity of the various organisms helps to keep the soil in good physical condition. Mulches also protect the soil aggregates from the destructive effects of beating rains. Further, by keeping the soil fairly moist near the surface they reduce slaking, which usually occurs when very dry aggregates are wetted. Slaking usually results in some degree of sealing of the soil surface.

In areas of excessive rainfall mulches may be used as a source of slowly available nutrients such as nitrogen. Under high rainfall conditions most inorganic forms of nitrogen are rapidly leached from the soil. Organic forms, if available, are usually expensive and thus beyond the means of most farmers. Leguminous mulches may offer a practical solution to this problem. Considering the limited production of fertilizers in the Tropics as a whole and the transportation problems often encountered, the production of nitrogen on the farm and its effective use in crop production, is a matter of great importance.

Figure 2. The only nitrogen received by this field of tobacco on 60 per cent slopes near Utuado, Puerto Rico, came from a mulch of Tropical Kudzu cut from a nearby field and applied at the rate of five tons of dry matter per acre. Note grass barrier used for erosion control running across bottom of the picture.

The high temperatures attained by the upper few inches of bare soil under the conditions of high sunlight intensity peculiar to the Tropics can seriously interfere with crop production. There is abundant evidence showing that temperatures as high as those recorded in bare soil at Aguirre can prevent or seriously delay the emergence of seedlings of many plants.

Temperatures such as these can seriously impair the growth and activity of plant roots. Thus, root activity may be restricted in just those soil layers where most of the plant nutrients are to be found. Desirable microbial activity is also undoubtedly restricted by temperatures of this magnitude.

The fact that these upper layers of unprotected soil also dry out very rapidly make conditions even more unfavorable for seedling emergence and growth, and for root and microbial activity. The high temperatures and drying out of the soil may also greatly enhance the fixation in unavailable form of such plant nutrients as potassium and ammonium.

(*Continued on page* 144)

Book Reviews

ECONOMICS OF AGRICULTURAL PRODUCTION AND RESOURCE USE. *By* Earl O. Heady. *Prentice-Hall, New York. 850 pages. 1952. $9.75.*

This book probably marks a high point in the agricultural economist's assimilation of the orthodox techniques of general economic theory. Virtually all the analytical tools of the theoretical economist—indifference curves, production functions, cost curves, demand functions, and the like — embellish the treatment of agricultural production. Starting with a discussion of the principle of diminishing returns and concluding with an evaluation of technological change and economic progress, most of this work is devoted to carrying relatively simple problems of allocation and output determination to considerable abstract refinement.

Conservation of agricultural resources is briefly treated as an extension of the familiar economic problem (competing uses vying for scarce resources) to include the consideration of the optimum use of resources through time. This discussion emphasizes the limited importance of conservation as one of the many factors that influence production plans and, following a somewhat mechanistic standard of welfare, Heady contends that the optimum rate of resource utilization (and therefore conservation) will usually be revealed through decisions made in the market place and the polling booth. Partly as a result of the adoption of this standard, many conservation issues are reduced to determinate solutions of simple propositions. For example, given limited funds for soil conservation work, prevention of the loss of an acre of Tama-Muscatine soil in eastern Iowa should have priority over similar losses of Shelby-Sharpsburg soil in northern Missouri. Readers may find such conclusions small fare after such elaborate preparations.

—L. G. Hines, *Hanover, N. H.*

PRINCIPLES OF FARM MANAGEMENT. *By* H. C. M. Case and Paul E. Johnston. *J. B. Lippincott Company, Chicago, 466 pages, 1953.*

Conservationists and farm planners will find this book particularly useful since the authors emphasize the farm planning technique in developing a well-coordinated farm plan.

The introductory chapter outlines the scope of farm management and defines the two phases of farm management—farm organization and farm operation. The authors point out the scientific principles involved in the complicated business of present day farming. They recognize the close association of the farm family with the farm business as an important aspect of individual farm management. For the most part, the principles discussed in this book are those designed to maximize net farm earnings over a period of time. Ways are skillfully delineated to conserve and improve agricultural resources.

The first eleven chapters constitute a unit which emphasizes the farm planning procedure and treats the problems of combining the agents of production, i.e., land, labor, capital, and management to form a successful farm business. The authors present a logical order of farm planning which will facilitate the development of a good farm organization: (1) an appraisal of the resources to be employed; (2) a long-time plan for land use and erosion control (with transition steps from the old plan to the new); (3) a livestock system adjusted to the needs of the farm; (4) a plan for inputs of labor, power, and machinery; (5) a revised farmstead plan; and (6) a plan for financing the changes and an estimate of annual inputs, returns, and net earnings. The planning procedure is illustrated, step by step, at the ends of chapters 4 to 11 by use of a Champaign County, Illinois, problem farm. Beginning conservation farm planners and those who have had limited farm management training will be particularly interested in this section of the book.

The last seven chapters of the text deal with the day-to-day problems of farm planners and farm managers such as size of farm and size of business, financing the farm business, the use of economic information, farm tenancy and farm leases, farm records and their uses and the significance of types of farming.

This text is well illustrated with 31 pictures, 48 figures and charts, and 98 tables. The many standards contained in these illustrations and tables, such as power and machinery requirements, estimates of labor needs, livestock feed requirements, housing and feed bunk space for livestock (all with data covering many variable situations), are as utilitarian to the farm planner and farm manager as the slide rule is to the engineer.

While corn-belt problems are emphasized, data and illustrations covering much of the agricultural area of the United States are presented in this book. The principles illustrated and discussed are applicable to all agricultural areas of the country. The planning procedures outlined can be used rather universally as a guide to developing well organized conservation plans and successful farm businesses.

The authors have developed wisely ideas in this book which have been checked against the experiences of successful farmers as recorded in many years of farm financial and detailed cost account records.

While the book is planned as a college text for beginning students, the principles of economics as they

relate to farm planning and farm management are incorporated effectively so that those working with farmers will find the book a welcome addition to their kit of "working tools."

—E. L. SAUER, *Champaign, Illinois*

MAKING RADIO WORK FOR YOU. *A Handbook for Extension Agents. 24 pages. U. S. Department of Agriculture. Agriculture Handbook 42. Division of Publications, Office of Information, USDA. Washington 25, D. C.*

Anyone who might conceivably appear before a microphone ought to get a copy of the Extension Service's latest handbook on using radio effectively. The material is geared for county agents, but it's also loaded with tips that will help even the most infrequent broadcaster in the agricultural field.

The publication is well-organized on the basis of questions that arise in planning, preparing and delivering typical farm programs. The various topics and subtopics are arranged and displayed for quick reference. A rundown on the main subject-headings gives a rough idea of the practicality of this aid: Program Building; Program Material and Scope; The Broadcast; Let Folks Know About the Program; Find Out Who Is Listening; Presenting Subject Matter; Help for the "Ad-Libber"; If You Must Write a Script; The Tape Recorder—Radio's Man Friday; Get to Know RFD; Commercial Sponsorship.

A vast debt of gratitude is owed the anonymous authors who place special emphasis on alleviating the traditional bleat—what shall I talk about? Their approach to this perennial cannot fail to relieve anguish in many quarters.

Adding to the publication's readability and solid usefulness are scores of cartoon-type drawings, plus abundant examples of how-to-do-it. In this last connection, there never was a better presentation of verbalizing successfully for the ear alone. And finally, let us be thankful for one radio handbook that skips the secret-society technical jargon that actually went out of date with headsets and celluloid collars.

—BERNARD A. ROTH, *Upper Darby, Penna.*

FOUNTAINS OF FREEDOM. (*Moral and Spiritual Values in American Democracy*), *By* GEORGE E. ROTTER, ANDREW A. WERESH, AND ERWIN GOLDENSTEIN. *Pacific Press, Mountain View, California. 1953. Price, $3.50.*

All of us who are enthusiastically interested in conservation education do not limit this kind of education simply to the conservation of natural resources. We are also interested in the conservation of human resources.

I recently came upon a new textbook which is, I feel, one of the answers to the problem of aiding directly in developing good traits among our young people. It is a basic textbook specifically designed to help ninth and tenth graders to develop such traits as thrift, honesty, courtesy, sharing, fair dealing, respect for parents, loyalty, charity and brotherly love. It instills a love for the land and an appreciation of the gifts of nature. I would rate this book as not only excellent for school use, but also as first choice for every home with adolescent children.

The need for more adequate citizenship education in our schools has been discussed a great deal in the last few years. School people who are serious in their determination to stress the importance of high moral fiber and good citizenship will find in *Fountains of Freedom* a textual instrument that is practical in pointing up the really important character traits.

The book is designed for use in the regular English or Social Studies program of the schools. It is a practical one for both pupils and teachers, since it carries a multitude of activities which will aid the pupil in developing worthwhile character traits, and in learning of the importance of these traits in every day living. Teachers will appreciate the concise Teachers Manual which accompanies the book.

A splendid treatise on soil conservation is also found in the book. This section is designed to impress young people with the need for soil conservation and their responsibility for acting as trustworthy custodians of the land. Other natural resources are given consideration as well.

It is my feeling that those of us who are members of the Soil Conservation Society of America, or who are affiliated with any other organization concerned with the conservation of human and natural resources, will do well to call FOUNTAINS OF FREEDOM to the attention of local school administrators and teachers. I believe a copy should be in the hands of every freshman and sophomore high school youth.

The authors are members of the Nebraska Department of Public Instruction who have been engaged in public school work for many years. They are closely associated with the Nebraska Conservation Education Program. Mr. Rotter is Supervisor of Conservation Education in the State Department.

—ADRIAN C. FOX, *Lincoln, Nebraska*

LAND-USE ORDINANCES OF SOIL CONSERVATION DISTRICTS IN COLORADO. *By* STANLEY W. VOELKER. *Great Plains Council Publication No. 5. Colorado Agricultural Experiment Station, Fort Collins, Colorado.*

This report is based on a cooperative study of the Bureau of Agricultural Economics, USDA, and the Agricultural Economics Section, Colorado Agricultural

Experiment Station. It is an authoritative analysis of the history of land use ordinances in Colorado where 13 soil conservation districts have adopted such ordinances at one time or another.

Persons interested in land use ordinances will find in this report much information that warrants study. The author analyzes and describes local controversies in three districts that led to a revision of the Colorado State law in 1945, nullifying all land use ordinances in the State and requiring them to be re-enacted under the provisions of the new law. He also tells about how three other districts have made land use ordinances function successfully. District governing bodies who may be considering enacting land use ordinances would do well to secure this report and study it.

Land use ordinances which have been adopted in Colorado are of three types: (1) Grazing regulations for open range, (2) blow land regulations to abate soil blowing, and (3) sod-land regulations to prevent plowing of certain lands without permission of the District Board of Supervisors.

Some of the earlier grazing regulations were declared unconstitutional. Others were never tested in the courts nor were they vigorously enforced. Blow-land ordinances were popular with local people, especially in areas where many non-residents operated. Sod-land ordinances have varied considerably from district to district. In three districts dissatisfaction with local administration led to abandonment of the ordinances. In a fourth district where most of the land is sub-marginal for crop production, the ordinance has effectively prevented any breaking of sod. In two other districts the high type of local administration has led to a very effective guidance of breaking sod-land in keeping with the spirit and objective of the ordinance.

The report discusses the legal requirements of ordinances, their practical requirements, election requirements, administrative requirements, and their effectiveness. Regarding the appropriateness of soil conservation districts' administering land-use regulations, the author says, "Colorado experience has demonstrated that the soil conservation district has remarkable vitality when its local leadership is strong and capable and its electors are well informed. . . . It should be recognized that a land-use ordinance is a drastic tool to be employed only in situations that demand drastic action." He points out that some districts have failed to use this tool properly. But where failures have occurred, they have stemmed from a lack of understanding of the legal technicalities or from poor administration and not from any fundamental weakness of soil conservation districts as a method of carrying out the democratic process.

—A. M. HEDGE, *Washington, D. C.*

NOTE. *The following additional publications are recommended for those interested in a study of land use regulations:*

1. *"Soil Conservation Districts and the Power of Land Use Regulation" by Edwin E. Ferguson. Reprint from Iowa Law Review—Vol. 34, No. 2, January 1949.*
2. *"Land Use Regulation in Soil Conservation Districts" published by USDA, Soil Conservation Service, January 1947. SCS-MP-29.*
3. *"Soil Conservation Districts in Action" by W. Robert Parks, published by Iowa State College Press, Ames, Iowa.*

FOOD AND COVER FOR FARM WILDLIFE. *Special Issue No. 6. Pennsylvania Game News. Prepared by* JOHN B. SEDAM. *Published by the Pennsylvania Game Commission. 78 pages. March, 1953.*

This picture story bulletin is a timely and interesting one. As stated in the forword "It gets down to the very grass roots of why land should be improved for beneficial wildlife. Everything in it is practical. Every farmer and sportsman should read it."

Here is a pictorial illustration of the wildlife on the farm with a natural black and white picture of each animal with brief information on each of the game birds, mammals and fur-bearers. The most common song and insectivorous birds, destructive insects, trees, shrubs and vines and farm crops are presented in similar manner. Examples of kinds of food and cover and their location on farm lands are given special attention and the illustrations are chosen to show good general farming practice and especially soil conservation measures.

The main portions of the booklet are divided into two chapters, one to show food and cover for wildlife on the better agricultural areas and the other to deal with marginal and submarginal farm areas. Throughout these chapters illustrations, titles and descriptions stress conservation farming. In addition to the cover page, which is a colored strip cropped farm shown from the air, there are four air maps of farms showing soil and water conservation practices of many kinds and of course setting forth in detail the practices designed to benefit wildlife. Anyone interested in improving excellent as well as marginal farm land will find many and excellent ideas and illustrations of what to do. As might be expected the pictures and written material are slanted toward the interests of sportsmen. Because of the recreational possibilities in the development of poor lands for wildlife special details—more than is usually expected of this type of picture bulletin—are given to recommended development practices. These include air maps and legends with specification paragraphs in addition to sketches of what the completed work should look like. This is an ingenious and effective way of presenting the future view to sportsmen, farmers and future farmers.

—WARREN W. CHASE, *Ann Arbor, Michigan*

AGRICULTURAL RESEARCH. *Agricultural Research Administration, United States Department of Agriculture.* THOMAS MCGINTY, *Editor. Vol. 1, No. 1, January-February, 1953.*

"The first issue of *Agricultural Research* marks a new milestone in our efforts to do a better job of reporting on research and regulatory work." These words from E. G. Moore, Coordinator of Research Publication, Agricultural Research Administration, express the hope that this publication will fulfill a need that has been felt for a long time, that of bringing new research to the attention of extension workers, agricultural teachers, press and radio services, and to other research workers. It also is intended to furnish reports of projects still in progress.

The publication, which will be issued monthly starting in July, is in readily readable form, well-illustrated by pictures and charts, and short enough for use by farm press and radio services. Its sixteen pages contain useful information for anyone interested in farming and homemaking. It should greatly reduce the present lag in bringing new discoveries and proven practices into general use.

The first issue contains highlights from research projects on crop yield "ceilings," grain storage, plant and animal diseases, housing plans, food experiments, and moth damage to clothing, as well as comments on the quality and quantity of research, better USDA Bulletins, and many other timely topics. Likewise, the second issue deals with a variety of subjects such as new developments in antibiotics in controlling plant disease, how to grow more corn per acre, improved methods of concentrating foods, breeding for a hot-weather cow, pasture irrigation, and new uses for the constantly growing surplus of fats and oils.

If the succeeding issues are as interesting as the first two, then *Agricultural Research* will quickly become one of the most popular and informative research publications ever to come from the Government Printing Office. Individuals actively engaged in agricultural research, extension and teaching (state and federal) may obtain this publication without cost by writing to the Agricultural Research Administration. Others interested in receiving Agricultural Research should send their subscriptions (one dollar a year for 12 issues starting with the July, 1953 number—to get the first three bimonthly issues, send an extra 45 cents) to the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

—WILLIAM H. HENEBERRY, *Urbana, Illinois*

PREVIEW FOR TOMORROW: *The Unfinished Business of Science. By* BRUCE BLIVEN. *Alfred A. Knopf, New York. 348 pages. 1953. $5.00.*

The future of mankind's material welfare is largely dependent upon the interaction of three variables, at least two of which cannot be readily predicted: population movement, scientific innovation, and the availability of resources. Bruce Bliven, science popularizer and staff member of the *New Republic*, has steered a cautious course between the extremes of neo-Malthusianism and scientific enthusiasm in appraising this important problem of the present and future. On the whole, however, Bliven believes that the long-run avalanche of births may well out-distance the steady and sometimes dramatic advances that science can be expected to make toward increasing the yield of existing resources and discovering new sources of supply.

Bliven recognizes than an unadjusted projection of the current high birth rate to the future may seriously overstate the actual increase in future population, but holds that it would be unwise to rely on such a happy outcome. As a result there is an urgency to his discussion of the necessity of checking world population growth by control of births, increasing output by scientific development, and maintaining resource productivity through the extension of conservation practices. Extravagant predictions of increased food production through such developments as hydroponics, mining the sea, and exploitation of the tropics are sanely deflated to their proper proportions.

Although slightly less than half the book deals with conservation of natural resources, Bliven covers a wide range of topics from shelter belts to water and air pollution in an interesting and moderately thorough manner. His discussion of natural resources leans heavily on such studies as the *Water Resources Policy Commission Report*, supplemented by interviews with scientists in various fields. Primarily because of its broad sweep, *Preview for Tomorrow* does not provide the extended treatment of any given issue that will be of interest to the specialist, but it is almost sure to contain information on some topics with which the specialist is unfamiliar and much that will be new to the non-specialist.

—L. G. HINES, *Hanover, N. H.*

OBSTACLES TO CONSERVATION ON MIDWESTERN FARMS. *North Central Regional Publication 28. Published as Bulletin 574 by University of Missouri College of Agriculture. 58 pages. 1952.*

This bulletin, prepared by the North Central Farm Management and Land Tenure Research committees, outlines obstacles to soil conservation on midwestern farms under the following nine major categories and suggests measures that may be used

in dealing with some of the difficulties.

1. Reluctance of farm operators to change old methods of farming, insufficient skill to lay out the conservation work, lack of accurate information on costs and benefits, and frequent changes in recommended conservation practices.

2. Organization problems on small farms where intensive crops are used to keep the family labor force gainfully employed.

3. Land holding and rental procedures that restrict the interest of either owners or renters to periods which are shorter than the time required to carry out a conservation plan, or to receive benefits equalling or exceeding the cost of the improvements.

4. Reluctance of farmers to pay out-of-pocket costs of making the necessary changes in farm organization.

5. The time lag between cash outlays for conservation work and returns.

6. The desire of farm owners and operators for high current incomes.

7. Uncertainty as to future prices and weather conditions, and the possibility of losing a considerable part of the money invested in the animals that are needed to process hay and pasture into readily salable products because of forced liquidation in poor crop years when livestock prices are low.

8. Differences between maximum long-run income to the individual farmer and a socially desirable level of conservation.

9. Relationship of conservation to the general problem of better farming.

It is pointed out in the bulletin that "These categories of obstacles are not separate and distinct. Instead, the various problems dealt with under them are closely interrelated. Changes to conservation farming involve labor and expense as well as additional investments in livestock and improvements. Farmers must make their decisions to incur the costs and to make the necessary additional investments in an uncertain environment. These facts underlie most of the difficulties encountered in getting the job done."

Inasmuch as the North Central Farm Management and Land Tenure Research committees are composed of representatives of 13 north central state agricultural experiment stations, the Bureau of Agricultural Economics and the Soil Conservation Service of the United States Department of Agriculture, and the Farm Foundation, this publication incorporates results of many different studies that deal with the problem. While numerous measures are suggested to overcome the obstacles, it is recognized that in many cases they are only partial solutions.

The North Central Farm Management and Land Tenure Research committees have underway several research studies designed to answer some of the important segments of the conservation problem. This bulletin is the third publication on the economics of conservation prepared by the North Central Farm Management Research Committee. The first, "Conservation Problems and Achievements on Selected Midwestern Farms," was published as Ohio Agricultural Experiment Station Special Circular 86 and the second, "Principles of Conservation Economics and Policy," published as Iowa State College Research Bulletin 382. These publications are an encouraging and practical outcome of the coordination of effort by state experiment stations and the United States Department of Agriculture in the economics of conservation.

ELMER L. SAUER—*Champaign, Illinois*

Conservation in the Shan States

(*Continued from page* 113)

mately 50 acres each were selected. One is grazed and burned, following the local custom, and the other is fenced and protected from both fire and grazing. V-notch wiers have been constructed in the valley below each watershed, and automatic self-recording waterlevel gauges have been installed to measure the runoff from each watershed. A self-recording rain gauge will also be installed so that the correlation between rainfall and runoff can be determined for both conditions of vegetation. The wet paddy fields below will be benefited by both the reduction in flood flow and by the sustained flow of water for a longer time.

Other departments of the Shan State Government are availing themselves of the technical assistance of the new Soil Conservation Department. When the Veterinary (animal husbandry) Department recently established a livestock farm near Taunggyi, they requested the Soil Conservation Department to make a soil conservation survey and a conservation plan for it. In addition, assistance was given in the application of conservation practices such as: Diversion ditches, contour cultivation and stock water reservoirs.

Demonstration farms operated jointly by the Agricultural (Extension), Veterinary, Forestry and Soil Conservation Departments are to be set up as soon as plans for their integration are completed. The Shan States are becoming soil conservation minded.

Mulches in Tropical Agriculture

(*Continued from page* 139)

Summary

Mulches will probably be more useful in the Tropics than they have been in temperate regions. In those areas in the Tropics where evaporation rates are high the year round, mulches can effectively reduce water losses of this type. By keeping the soil cool and moist, under the conditions of strong sunlight intensity that obtain in these areas they favor seedling emergence and growth as well as root development and desirable mocrobial activity in the upper layers of soil. By protecting the soil from the impact of the torrential rains they help to keep it porous, and reduce run-off and erosion. They also help to control weeds, which run rampant in the Tropics. Finally, they can be used as a source of nitrogen fertilizer. The right kind of mulch, properly handled, can provide an economical and continuous supply of nitrogen for plant growth under conditions where most commercial fertilizers are quickly washed away or leached deep into the soil.

Field Notes and Comments

Gabrielson Receives Aldo Leopold Memorial Award

Dr. Ira N. Gabrielson, president of the Wildlife Management Institute, was presented the Aldo Leopold Memorial Award, conservation's highest honor, on March 10 before 875 persons including 151 members of Congress at the annual banquet of the 18th North American Wildlife Conference. The Wildlife Society, donor of the award, called Dr. Gabrielson's accomplishments as a fearless administrator of wildlife resources and as a relentless foe of those who would exploit the natural resources of the continent an outstanding example of selfless devotion to conservation's greatest principles.

Dr. Gabrielson began his career in 1912 as a school teacher of biology at Marshalltown, Iowa. Three years later, he entered the U. S. Biological Survey as a biologist and rose, in 1935, to chief of the federal conservation organization. As chief of the Biological Survey and the first director of its successor, the Fish and Wildlife Service, he nurtured the newly organized cooperative wildlife research unit program and fostered the development of national wildlife refuges. He retired from government service in 1946. He is author or co-author of five full-length books and many scientific papers and popular articles on ornithology and wildlife conservation. Dr. Gabrielson has served as chairman of the International Union for the Protection of Nature and the American delegation to the International Whaling Conference.

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Highlights of the North American Wildlife Conference

Approximately 1,200 persons, including internationally renowned experts on the management of renewable natural resources, biologists, conservation administrators, and representatives of sportsmen's organizations attended the 18th North American Wildlife Conference in Washington, D. C., from March 9 through 11. Represented in the attendance were people from nearly all the states, provinces of Canada, Alaska, Mexico, and Sweden.

The theme of the conference was *"Natural Resources and Human Needs."* John A. Hannah, assistant secretary of Defense, presided as chairman of the first general session. He was assisted by Harris Collingwood, analyst in conservation and natural resources, Library of Congress. Authorities who participated in a discussion of the relationship of human populations and available natural resources were Douglas McKay, secretary of the Interior; Kingsley Davis, director of the division of population research, Columbia University; L. G. Hines, head of the department of economics, Dartmouth College; Charles E. Lively, chairman of the department of rural sociology, University of Missouri; and J. G. Harrar, deputy director for agriculture of the Rockefeller Institute.

Dean Hardy L. Shirley of the college of forestry, Syracuse University, served as Chairman of the second general session, and was assisted by Waters S. Davis, president of the National Association of Soil Conservation Districts. Current trends in land and water use were discussed by a panel of experts. Dr. Richard E. McArdle, chief of the U. S. Forest Service, spoke on multiple use of national forests. Dr. Robert M. Salter, chief of the U. S. Conservation Service, outlined the objectives of that service organization. Elmer T. Peterson, editor of the *Oklahoman-Oklahoma City Times*, pointed out the fallacies in the Army Engineers' downstream flood control program for the Washita river watershed in the Missouri river drainage. Mr. Peterson, author of several nationally acclaimed articles on the inadequacies of downstream flood control by erection of costly water storage facilities, cited the fact that dams constructed by the Corps of Engineers in Oklahoma

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failed to control floods three times in the past eight years.

Other speakers at the second general session were Hugh B. Woodward, attorney-at-law, from Albuquerque, New Mexico; R. L. Dushinske, North Dakota publisher, and Nathan Tufts, president of the Connecticut Valley Watershed Council.

The final general session featured a discussion of the topic, *"Living Space for Waterfowl,"* by several prominent authorities. P. W. Schneider, director of the Oregon Game Commission, served as the session chairman. Participants in this session were W. Winston Mair, chief of the Canadian Wildlife Service; Angus Gavin, general manager of Ducks Unlimited; J. M. Anderson, superintendent of the Winous Point shooting grounds in Ohio; Hayden W. Olds, director of the Tennessee Department of Conservation; Ernest Swift, director of the Wisconsin Conservation Commission; and J. P. Linduska, chief of the branch of game management, U. S. Fish and Wildlife Service.

Throughout the conference six technical sessions devoted to specific problems in all phases of natural resource management were also conducted. Dr. C. H. D. Clarke, supervisor of wildlife management in Ontario, presented an appraisal of all the general and technical sessions of the 18th North American Wildlife Conference. A premier showing of Walt Disney's *"Prowlers of the Everglades,"* a true-life adventure picture, was an entertainment feature at the annual banquet.

Fonda Joins Harvestore Division

Morris E. Fonda, past-president of the Soil Conservasion Society of America, has joined the Harvestore Division of the A. O. Smith Corp. in the role of agricultural specialist. He will assist the Harvestore Division in agricultural relations and sales promotion of its glass-lined silos and allied equipment.

Fonda, who has been in close association with state agricultural colleges and extension services all over the U. S., spent 14 years with the Department of Agriculture and most recently was agricultural relations consultant with Ferguson Farm Equipment Co. at Detroit.

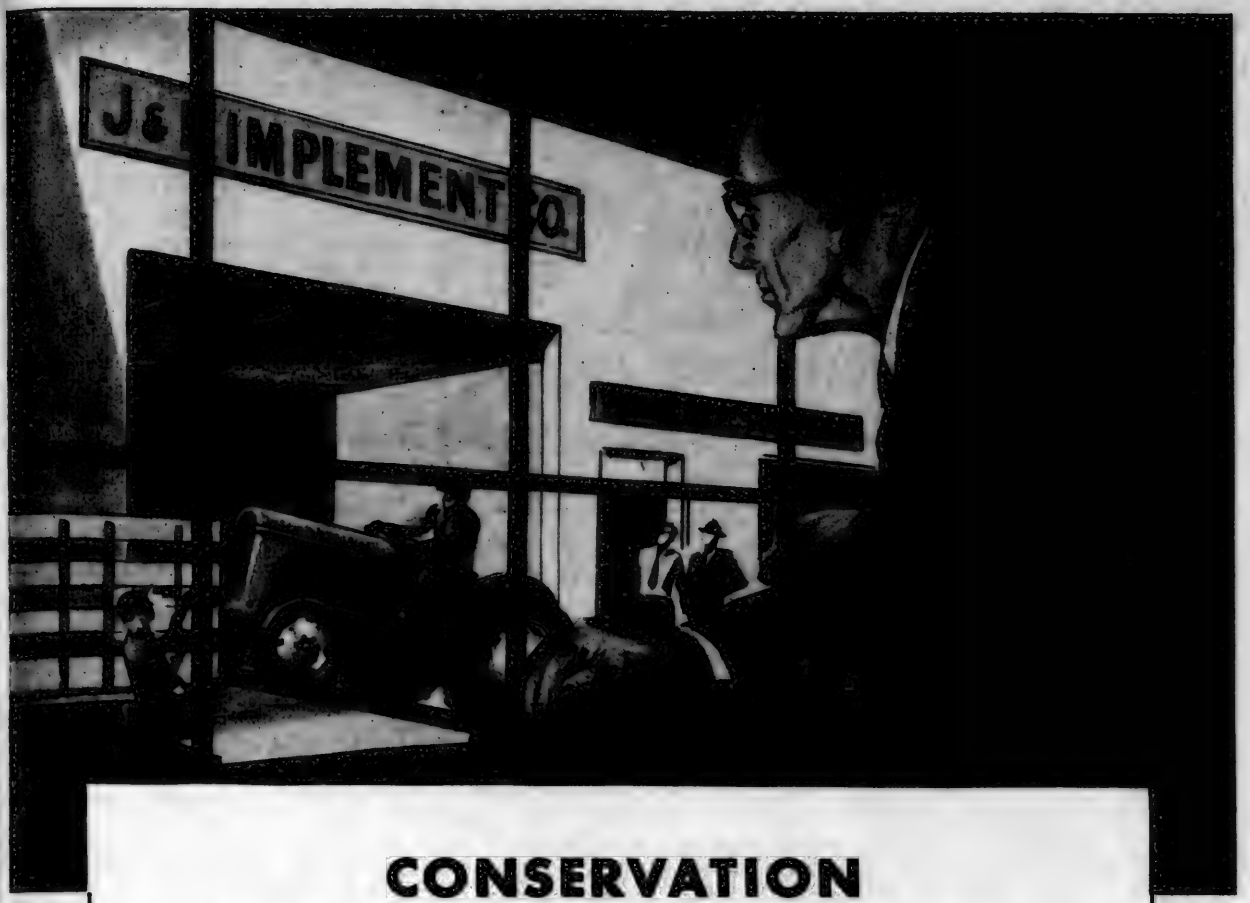
President of the Soil Conservation Society of America in 1951-52, Fonda now is National Council member. Other committee associations have been with the International Grassland Conferences, the Future Farmers of America and as land consultant to the Rural Life Conferences at Manizales, Colombia. The latter was sponsored by the Catholic Church and the F.A.D. of the United Nations.

He will make his headquarters at the Milwaukee Works of A. O. Smith Corp.

Native Americans Given Conservation Award

Tuesday, March 17, 1953, over 100 representatives of various service and civic vlubs from Roosevelt, Vernal and Fort Duchesne joined in a dinner meeting to honor two native Americans, Mr. Herman Crumbo and his wife. At this dinner Mr. Crumbo was presented the *Conservation Service Award* of the Department of the Interior. He is the first dirt farmer to have received this honor. The significance of this can be best emphasized by the fact that modest Herman Crumbo was one of nine individuals cited by Secretary Chapman for their contributions to the advancement of conservation of the Nation's natural resources. Each of the other eight was engaged in fields other than agriculture. Mr. Crumbo's accomplishment and its significance is summarized as follows in the Secretary's citation:

Mr. Crumbo, a Potowatomi Indian married to a member of the Ute tribe of Utah, has developed his farm on the Uintah and Ouray Indian Reservation in the Uintah Basin of eastern Utah during the past five years in such a manner that he has made an outstanding contribution to the conservation program, not only of his community, but also of the Interior Department.



CONSERVATION IS EVERYBODY'S BUSINESS

There's a growing awareness among farmers that their stewardship over the land must not be taken lightly. Not only farmers, but others in business and industry feel that conservation is *their* responsibility, too.

And direct action is being taken *locally,* in the true American tradition, through Soil Conservation Districts.

These Soil Conservation Districts work unceasingly to bring more and more farmers and more and more farm land into the conservation movement.

Manufacturers of farm equipment and their dealers are co-operating . . . by assisting in demonstrations . . . providing modern equipment . . . and in many other ways.

Harry Ferguson, Inc., and its Dealers, pledge continuing support in this important work.

Building a better world through better farm mechanization is the business of Harry Ferguson, Inc., Detroit 32, Mich.

FERGUSON TRACTOR *and 63 Ferguson System Implements*

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HYDRAULIC Scoopmaster
MOVES DIRT FASTER - EASIER
Handles Every Dirt-moving Job!
IT LOADS!
IT CARRIES!
IT DUMPS WITHOUT STOPPING!
Ideal for soil conservation work, landscaping – builds terraces, dams, ponds, roads.
★ Can move 60 yards an hour.
★ Capacity one yard.
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Professional workers in soil and water conservation and related fields will want copies for reference purposes; also students of agriculture, agricultural libraries of high schools, colleges and industries. Vocational Agriculture Instructors, County Agents, Extension Specialists, members of soils departments, experiment stations and college instructors will find the Soil and Water Conservation Glossary useful.

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Following the recommendations of the Indian Bureau Soil and Moisture Conservation technicians and with financial assistance from the Production Marketing Administration through its ACP program, Mr. Crumbo, by hard work, has developed a river bottom farm that was largely brush, weeds and waste into a highly productive farm that is providing him a nice income and enabled him to build a new home this past year.

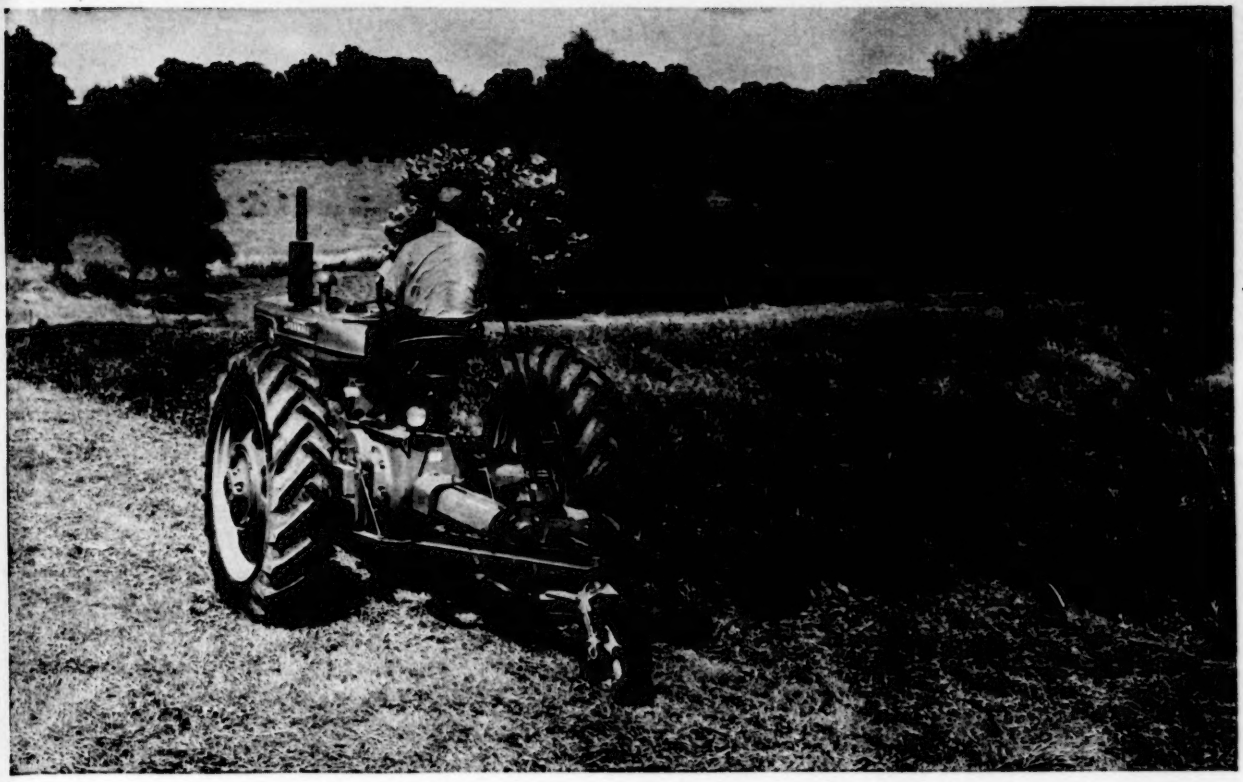
"Through development of your farm on the Uintah and Ouray Reservation in the Uintah Basin of Eastern Utah," the citation read, "you have contributed materially to the Conservation Program of the Department.

"In 1947, when you purchased the land which now comprises your farm, it was a completely unproductive waste, covered with brush and weeds. During the subsequent five years you took advantage of the advice afforded you by the Branch of Soil Conservation, Bureau of Indian Affairs, by applying progressive conservation farming methods on your land. Because of this, and through your own diligent efforts, your land has become a productive farm with profit to yourself and your family. Most important of all, however, you have shown the way to both Indian and non-Indian farmers in the Uintah Basin relative to the benefits of applying conservation methods. In this connection you have greatly aided soil conservation technicians by providing them with a shining example of the end product of the procedures which they advocate."

—EVAN L. FLORY, *Chief, Branch of Soil Conservation, Bureau of Indian Affairs, U. S. Department of the Interior*

Agriculture Department's Flood Prevention Work Reassigned

In a move intended to expand and improve the flood prevention work of the Department of Agriculture, Secretary Ezra Taft Benson recently assigned the department's flood prevention activities and river basin investigations to the Soil Conservation Service. Heretofore, these activities were administered by a staff in the Secretary's office. Leadrship for field work had been delegated to the Soil Conservation Service or the Forest Service depending on the prominent use of the land in the watershed under study.



How soil conservation promotes BETTER LIVING

When you look at a pleasant farm scene like this, you're seeing first-hand evidence of what soil conservation means to this farmer, as a contribution to his way of life. To him, soil conservation—with the help of modern McCormick farm equipment—means *good living.*

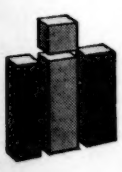
Here are three ways in which his soil conservation program helps provide good living.

▶ *First*, there's the lush growth of alfalfa that supplies rich, blossom-fresh feed for his livestock. And thanks to the productivity of his soil, he will get two more cuttings from this field this year. At the same time, the deep-probing alfalfa roots are improving soil structure and adding valuable nitrogen to the soil.

▶ *Second*, there's the farm pond in the background, bordered by cool shade and grassy banks. He and his family find recreation there—a quiet place to fish, a dandy place for his youngsters to swim and float a raft.

▶ *Third*, there are the rolling hills in the distance, for pasture for his livestock, or for contoured row crops sandwiched between strips of hay and grain.

These are some of the rewards of proper land use. International Harvester designers, engineers, product specialists and dealers are constantly striving to find better ways to make McCormick farm equipment more useful in carrying out recommended soil conservation practices—to promote good living on the land. They know that whatever helps promote better land use helps make a stronger agriculture—and a stronger America.



INTERNATIONAL HARVESTER

International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors... Motor Trucks... Crawler Tractors and Power Units... Refrigerators and Freezers—General Office, Chicago 1, Illinois

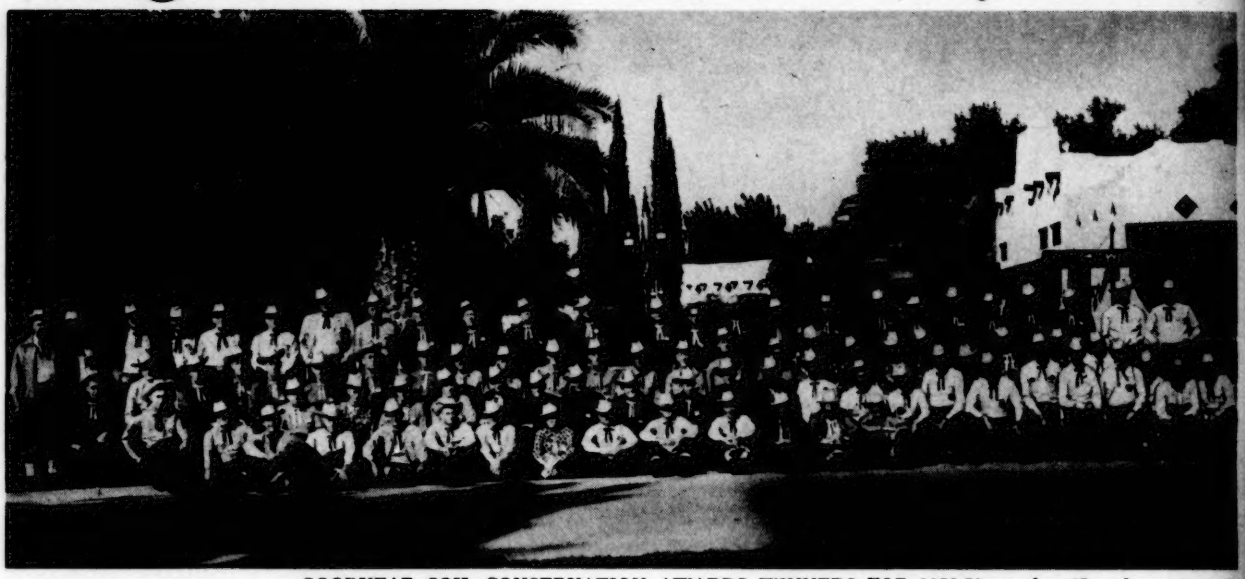
PRESIDENT EISENHOWER SAYS:

"The best natural resources program for America... will involve a partnership of the states and local communities, private citizens and the Federal Government, all working together."

Thank you, Mr. President –

AND WE ARE HAPPY TO ANNOUNCE THAT THE

Goodyear Soil Conservation Awards Program Goes National, July First!



GOODYEAR SOIL CONSERVATION AWARDS WINNERS FOR 1952-53 *number 67 and represent 9 states. Here they are at Litchfield Park, Arizona, with their Goodyear hosts. Goodyear's next contest, beginning July 1, 1953 and ending April 30, 1954, will have 100 winners – and from every state in the Union!*

THROUGH ITS FARM TIRE SALES DEPARTMENT, Goodyear has long been an enthusiastic supporter of soil conservation districts. Among numerous such activities on behalf of our farmers and our nation, Goodyear sponsors a Soil Conservation Awards Program which, each year, has sent winners from selected farm states on all-expense-paid vacation trips to The Wigwam, at Goodyear's model farm, Litchfield Park, Arizona.

This annual contest has been so enthusiastically received on a regional basis – and has so successfully alerted farmers to the possibilities of soil conservation in their areas that, on July first, the program goes NATIONAL! Yes–

100 SOIL CONSERVATION DISTRICTS FROM ALL 48 STATES WILL RECEIVE BRONZE PLAQUES– AND 100 PERSONS WILL WIN GRAND AWARD FREE VACATION TRIPS! Any of the more than 2500 soil conservation districts in continental United States, may compete. For complete details, without obligation, see your nearest Goodyear Farm Tire Dealer– or your local soil conservation district office or county agent. Goodyear, Farm Tire Department, Akron 16, Ohio.

GOODYEAR

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